

CHEMICAL & METALLURGICAL ENGINEERING

New York, July 15, 1918

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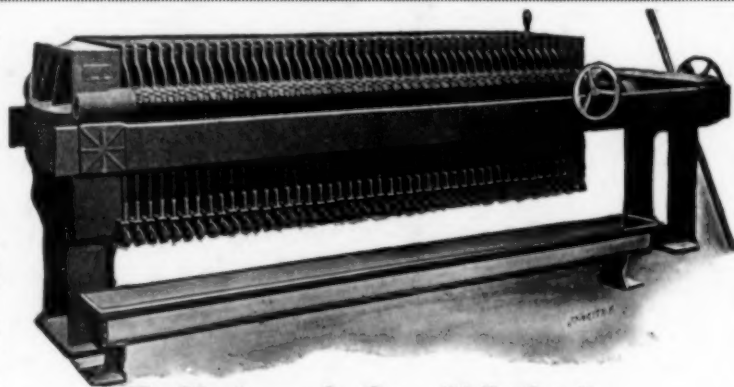
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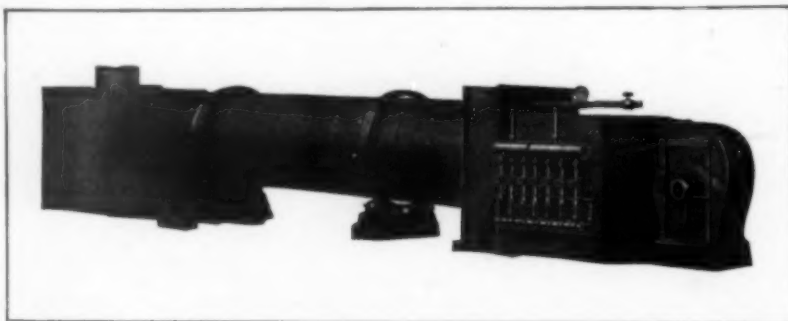
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Economics of Prices and Production in War Time

PROBABLY every engineer has, at some point in his education, gained at least a smattering of the science of economics. If his experience coincides with ours, his study of the subject was rather superficial, due to pressure of other work deemed more important, and his recollection of it is confined to a few hazy notions on the law of supply and demand. As a logical consequence he is likely to be a bit confused when the subjects of price-fixing and *laissez faire* are expounded by their proponents as cures for the economic evils that beset us in war times.

It is with a view to clarifying the situation somewhat that we have asked Professor McCrea of Columbia University to write a brief exposition of the economics of prices and production in war times. His article appears elsewhere in this issue, and we believe engineers generally can afford the time necessary for its study, and that they will feel repaid for the effort. Professor McCrea has picked illustrations and phases of the subject appropriate to the engineering profession.

Buying a Scientific Pig in a Poke

IT IS doubtful if any organization other than Congress could have been induced to heed the representations of a comparatively unknown scientist on the mere claim that he had a mysterious and wonderful machine for the development of energy. Congress does some things well, but when it dabbles in science and engineering it is likely to make a poor showing.

For some time now we have been awaiting the revelations promised by Garabed T. K. Giragossian as a result of official encouragement granted him for the development of whatever it was he had in mind when he induced Congress to back him. The report of the investigation committee, composed of four Massachusetts Institute of Technology scientists and a fifth engineer, is brief and negative. It is about what all engineers anticipated, certifying that the model was not in shape to run or develop power; also that "the inventor admitted that he had no working machine and that he was merely explaining principles." Apparently the "principles" did not satisfy the committee, because they are dismissed as unsound, and the device is discredited as inoperative. In short, the bubble burst when exposed to mere inspection.

The inventor is reported to be undismayed, and still determined to demonstrate his idea and force its acceptance by an unwilling and ungrateful government. The sooner the incident is dismissed and forgotten, the

less likely it is that other inventors of perpetual motion machines will seek the ear of Congress and implore official recognition. We hope the time will come when sound engineers can get as much recognition on their merits, as fanciful dreamers secure through persuasive powers of speech and glittering promises.

Administering Alien Property

IN taking over the vast amount of enemy alien property by the United States Custodian we have been very favorably impressed with the high class of men who have been appointed as administrators. The majority of names, which at first glance are familiar to us, are those of gentlemen who have successfully administered estates of immense value either as owners, trustees or corporation officers. We do not observe, however—and we say this subject to correction for not having the complete list before us—names of men having the technical training to understand the nature of the business which they have in hand, in chemical manufacture.

Now, chemical industry does not accord with the convention which became established in the joyous old days, to the effect that given a factory with machinery, a lot of workmen and a superintendent, it was bound to succeed if only the members of the board of directors were all successful men. It doesn't work that way at all. A banker, a broker, a street railway magnate, a dry goods merchant and a lumber king, no matter how rich they may be, are not the right persons to make chemical products or to sell them. Their time is worth too much to waste it in doing nothing, and the mere formality of attending board meetings without understanding what is going on, is waste. It is chiefly in German-owned works that many enemy aliens are employed as managers and superintendents as well as technicians. Therefore we hold that at least one member of each board of directors of every German-owned chemical works should be an American chemist of high standing. Otherwise, no matter how competent the board is, the insiders may put something over on the directors that will only be discovered after it is too late.

Enemy property should be conserved, and properly conserved, because as a people we still remain civilized, and if we hold our heads high and keep up our faith, German depravity will not spread its infection among us. But as to the wisdom of the appointment of men of technical training to these boards, we think it important, and we urge it upon the Custodian of Alien Property. There are many reasons why it should be done, and we know of none to the contrary.

What Does the Employer Expect of the College-Trained Chemist?

WITH the purpose of gaining the point of view of the manufacturer regarding the qualifications which lead the college-trained chemist to a successful career and rapid promotion, the *Kansas Chemallurgist* sent out enquiries, some of the replies to which are printed in the May issue. The general consensus of opinion was that personal characteristics were equally as essential for stepping to the front of the ranks of the chemical profession as pure scientific knowledge and training. Such qualifications as honesty, initiative,

imagination, enthusiasm, persistence, aggressiveness, tact, loyalty and progressiveness were cited with emphasis. One writer thought these qualities should not be regarded as gifts, but as the acquirements of a properly directed mind which became natural, just as any physical habit does, by practice.

Dr. W. R. Whitney of the General Electric Co. may well be quoted: "We expect of each man at the start certain definite things, but when he does only what we expect from him, he does not get along as rapidly or as well as when he exceeds our expectations, and that is the kind of man to train, if possible. For example, a man trained as an analytical chemist may be added to the force. It is satisfactory if he is and remains a fair analytical chemist, but it almost always happens that opportunities come to him for extensive or special work. It may be no more than extensive development of the appreciation of the uses of analytical chemistry in our field. Or it may be that, because of his particular interest or enthusiasm, he develops into an expert in some line, such as electric-furnace products, tool-steel manufacture, etc. The actual manipulation necessary for the chemist in the analytical field as applied to our own experience is not difficult enough or rare enough to warrant high salaries, except where it is combined with what may be called interpreting powers. An analytical chemist who actually performs all the analyses needed in a running laboratory, but does nothing else, can seldom be paid a decent salary, because there are so many of them."

Without doubt, the chemist who gets the coöperation of his associates and has the power of uniting his forces in their best formation for attacking his work is just as much of a leader as any of our executives, civil or military. To do this, he must have character, the more important attributes of which have been mentioned. The employer seeks the man that can promote the welfare of the firm and be promoted himself in return. To do this, he must have the correct point of view and the will to execute his conceptions. Then he will always produce the desired results.

Post-War Problems in the Chemical Industry

IN RECENT issues of CHEMICAL AND METALLURGICAL ENGINEERING we have been directing attention through a series of articles by our Washington representative to the imperative necessity of beginning at once to plan for the reconstruction of our industries after the war. The inevitable readjustment that will be necessary when peace comes should be anticipated by the best minds in the industry so that the change will be made with as little dislocation as possible.

It must be evident to all that our chemical industry, being basic in the production of munitions of war, has undergone tremendous expansion. Production far exceeds anything known or needed before the war, and the troublesome question arises, What are we going to do with our production when the abnormal demands of war no longer exist? The answer will not be so difficult in the case of those chemical products which are new to this country and which will supplant former importations; but in the case of acids and alkalies, chlorine, ferro-alloys, air-nitrates and some other products in

which we have had a tremendous expansion there will be need of careful and constructive thought. The use of these materials must be extended in proportion as their production has expanded or there will be economic loss and waste.

Great Britain already has approached the problem of sulphuric acid overproduction, and the makers have been in conference on the advisability of forming a National Sulphuric Acid Association. Recommendations have been made looking toward the use of excess acid in the manufacture of fertilizer and the more extended use of that material. Vitally and intimately related to this program are the subjects of cheap transportation, education of the farmer, equitable taxation and a scheme for the scrapping of useless plants. The coöperation and support of the Government is sought and expected.

In our own country we have such agencies as the Chemical Alliance and the American Chemical Society which should take the initial steps toward protecting our chemical industry when peace comes. Both organizations are directed by leaders in the industry, and are favorably situated to sense its post-war problems. Investigations should be started at once, preferably by men whose minds are free from concern with the problems of present production. A symposium on the subject at the Fall meeting of the American Chemical Society should be of inestimable value if properly organized.

Profits and Profiteering

THE Federal Trade Commission's report on "profiteering" was made public June 29 and immediately there arose a storm of criticism in many branches of the trade press. Perhaps if the Commission were afforded an opportunity to comment upon the editorials that have been written about its report it would find as much occasion to criticise the editorials as the editors found to criticise the report. It could take advantage of the editors in one respect, by giving the editorials the careful reading it is evident some of the editors did not give the report.

The report has been dubbed "extraordinary," for instance, but that is not particularly remarkable in a report on a practice that is so extraordinary that its very name has not hitherto been recognized by the lexicographers. It is suggested also that the report reminds one of the "muckraking" days. A careful reading of the report, however, from the viewpoint of the circumstances which moved the Senate to call for it, does not indicate that it is such a remarkable document after all. The chain of circumstances that led to it was short and closely linked. On May 27 the President appeared before Congress and asked that the session be prolonged to consider the taxation program for the calendar year 1918, four billions having been the estimate for the taxes levied against 1917, while the amount would have to be increased greatly. The President said:

"There is abundant fuel for the light in the records of the Treasury with regard to profits of every sort. The profiteering that can not be got at by the restraints of conscience and love of country can be got at by taxation. There is such profiteering now and the information with regard to it is available and indisputable."

The Senate accordingly called upon the Federal Trade Commission for a report giving such information as the

Commission had available as to how profiteering could be got at either by taxation or by enactment of more effective criminal statutes. The Commission in its report, however, does not propose any additional criminal statutes, but rather reports that there are cases of men violating existing law, and that "The Federal Trade Commission has been vigilant and untiring in its exclusion of these practices." It does point out that there are large profits, and that is precisely what Congress desired to find. That is not a hallucination on the part of the Commission, not even a new discovery. When price-fixing was being discussed, about a year ago, it was the common contention of producers that the most efficient method of procedure for the Government would be to allow large profits, and then tax those profits as far as necessary. Perhaps it was poor advice, but at any rate it has never been formally withdrawn.

The Commission deserves much credit for bringing out strongly a very practical and important fact in connection with profits and production, and that is that in a given industry there are likely to be large profits and small profits, from which the Senate will experience no difficulty in deducing that the efficient thing is to tax profits on a graduated scale rather than reduce prices until the profits of the more efficient producers become normal and the profits of the less efficient are converted into losses causing them to cease production.

Criticism of the Federal Trade Commission's report, rather a tame document on the whole, but marked by some lurid language which is not illuminating and had much better have been omitted, apparently loses sight of the fact that the Commission has had an important part in the fixing of prices, being constantly consulted by the War Industries Board and the President. If it desired any general scaling down in prices its representations would have been made in those quarters and would not have been held back for presentation to the legislative body when the latter is seeking profits upon which to levy taxes.

On the whole, the report clears the situation somewhat, though to no great extent. It is more important in what it does not say than in what it does say, except as to the one point that it emphasizes the fact that profits vary greatly among the different producers in an industry. Congress can now forget about "profiteering," for which there is no precise definition, and address itself to the taxing of "excess profits" or "war profits" which can be defined precisely, in dollars and cents, in various ways. The law taxing 1917 profits defined the excess by a scale of percentages based on capital investment. The original House bill had taken the average profits of 1911-12-13 as a basis. Lately the British system has been proposed, based on the two best of those three years. The President told Congress that the present tax laws "are marred, moreover, by inequities which ought to be remedied," and yet it appears the taxes were computed and paid without a great deal of difficulty. It has always been a debatable question how much capital the United States Steel Corporation has invested, yet although the tax is based on capital investment it appears that the Corporation paid precisely the tax it computed before the time had arrived for it to make its taxation report to the Treasury Department. The prospects are that a suitable tax law will eventually be enacted.

Readers' Views and Comments

Molecular Physics of Ore Flotation

To the Editor of Chemical & Metallurgical Engineering

SIR:—I would like to correct a misstatement by Coghill and Anderson in their recent article entitled "On the Molecular Physics of Ore Flotation."

This statement is as follows:

Other writers have made similar attempts (calculation of capacities) by using principles incorrectly. The most striking case is that of Van Arsedale. He begins with the promise that "the maximum weight that can be supported on the surface of water is equal to the surface tension of the area supporting the weight." Beginning thus with a false premise naturally he ends with false conclusions. It is scarcely hypercritical to say that for these fallacies to go unchallenged, after receiving favorable editorial comment and being incorporated in a book, portends a tardy science of flotation.

The portion of my article referred to read as follows:

We can then ask the question, How and why does a particle heavier than water float on a water surface? and if we can answer this we can expect considerable light on the whole subject. It is obvious enough that if a needle or anything else specifically heavier than water floats it does so primarily because of the effect of surface tension.

Now if this is true, there should be a relation between surface tension factors and the maximum weight that we can support on a water surface, and if we can experimentally verify such a relation we can consider our assumption proved.

It has been stated that the maximum weight that can be supported on a surface of water is equal to the surface tension of the area supporting the weight: that is to say that one square centimeter will support about eighty-one milligrams. As a matter of fact it can easily be shown that a square centimeter of water will support much more than this weight. We can however derive the relation we are after from the surface tension formulas for the difference in pressure between two sides of a curved surface. By the use of these formulas we can calculate the maximum size of cylinder that will float, and can verify our hypothesis experimentally by floating, for example, clean copper wires of various sizes. The maximum size of copper wire, when calculated thus, is about seventeen or eighteen B. & S. gage, depending on the area of contact. By careful manipulation we can float a wire of a size very close to that calculated, and can therefore be sure that our hypothesis is correct.

At the time my article appeared there were several flotation "theories" and the object of my argument was to show that flotation was due primarily to surface tension. This may seem superfluous now in view of our increased knowledge of the subject, but at that time flotation was popularly a "mystery."

It is, I think, obvious from my article as quoted above that I do not use the statement quoted by Coghill and Anderson as a premise at all but do prove that the statement is wrong, and that a close approximation to the maximum weight of a particle of either spherical or cylindrical shape that can be floated can be calculated by the use of the formulas given. A correction was later made of a transposed formula, but the conclusion I think remains correct.

It was distinctly stated in the article that details were not gone into and the figure given therefore of about seventeen gage copper wire as the largest size capable of flotation was only approximate, and furthermore as stated the size depends on assumptions made as to the amount of wet surface. The object of the

argument was not to determine an exact size of particle but to prove that surface tension was the primary cause of flotation, and not more or less obscure "electrostatics." The agreement between the calculated figure and that experimentally obtained while possibly not so exact as that obtainable by more elaborate methods was sufficiently so for the stated purposes of the argument.

In any case I think it will be clear from the above that the authors of the present paper were not warranted in making the statement that I used as premise the obviously incorrect statement given, but on the contrary this is distinctly given as a quotation and is proved to be wrong.

G. D. VAN ARSDALE.

Douglas, Ariz.

The Recent Flotation Decision

To the Editor of Chemical & Metallurgical Engineering

SIR—It appears that the U. S. Circuit Court in California has overruled the District Court in Montana, and concluded that the Supreme Court did not mean 1 per cent of oil or fractions thereof, but $\frac{1}{2}$ per cent of oil and less.

The California Court in substance decides that extraneous oil added for no purpose other than to avoid infringement may be classed as process oil and considered as oil desirable or useful in flotation results. The issue is forgotten, or not understood, that the essential oil in kind and degree, as described in the flotation patents at issue, is used to obtain the results, and that the extraneous oil is a neutral non-essential grade, not improving results but rather hindering them.

If it were shown by defendants that there was advance in the art, or a new process discovered by the use of oil, in any way, in excess of 1 per cent or even in excess of a fraction of 1 per cent, then the ruling of the California Court would be understandable. As it is, there appears no reason to doubt that the Supreme Court will again rebuke the California decision and stand on the broad ground it has taken, that the patents of Messrs. Sulman, Picard and Ballot are valid and must be broadly sustained.

If new evidence is shown, not now known to the profession, there is of course a chance to nullify the invention of Messrs. Sulman, Picard and Ballot as anticipated by prior art. If invention can be shown by advances in the art as described and practised under patents of Messrs. Sulman, Picard and Ballot, then a new flotation invention exists that may have individual standing.

I was called upon to give opinion in this issue prior to the Supreme Court decision, and I maintained that the Delaware Court must be sustained by the Supreme Court as it was. When the issue was started afresh regarding the use of excess oil to avoid royalty payments, I maintained that the Court must decide that the process of Messrs. Sulman, Picard and Ballot was still being used, no matter what excess of foreign matters like neutral oil existed, unless a new flotation process could be shown, with results that were not obtained solely by the use of the minor fraction of suitable oil

and the proper degree of agitation, as called for by patents mentioned. The Montana courts did so find, and I trust I may be permitted to again express opinion, for the issue to my mind has always been very clear.

There appears a lot of camouflaging and irrelevant matter in opinions expressed that, like the California decisions, show the minds do not grasp the real issue. The fact is that a commercial advance was created by the process of Messrs. Sulman, Picard and Ballot and was at once grasped by industry with immense profit. We may also say that unfortunately the patents were exploited for gain rather than administered by the inventors or a research board, but while this fact may excite opposition and litigation, it cannot change the legal status. Custom has devised no other form of meeting the money power of industry.

The Supreme Court recognized invention, saw the large benefit to community interests, the object of our patent laws, and saw that the process was one of degree and hard to define. In using the 1 per cent of oil definition of degree, the Supreme Court sustained the reading of the claims as a liberal interpretation, and it will be found that the use of much more than 1 per cent of oil will not break the patent protection, unless some new process or result is obtained thereby, and the burden of proof will be upon the inventors of this new process to prove it, which has not been presented.

It seems to me that the opinions and editorials I read are discussing words rather than issues and I can see no purpose in discussing the per cent of oil without the results and purpose of that oil, and as to the use of the term "critical" I feel that it was a fair term to use, when used in the light of the kind of oil and condition of agitation. It will be ruled that the per cent of oil has little bearing on the issue so long as the active oil that does the work is a fraction of a per cent which has been true up to the present.

The Supreme Court must protect invention that is the basis of community advance, and thus patent law; and in order to avoid royalties to owners of the Sulman, Picard and Ballot patents industry must show that results are not obtained by the critical conditions demonstrated by those patents. If Messrs. Sulman, Picard and Ballot were not the first to demonstrate, then the patents may be vacated, but on no other grounds.

PARKER C. CHOATE.

Essex, Mass.

The Microscope in Ore-Dressing

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having read with interest the article, "Approximate Determination of the Minerals in Concentrates by Means of the Microscope," by Kirby Thomas and Frederick W. Apgar, I am enclosing a brief outline of the use of the microscope in the Missouri School of Mines Laboratories. This outline was written some years ago so does not mention the article above noted.

This outline under methods No. 1, 2 and 4, shows three uses which Messrs. Thomas and Apgar do not consider. In method 2 the microscope had been found very helpful as the disappearance of the middling can be readily noted and the most economical size for crushing can be determined. In performing some experiments on the flotation of copper carbonates after

sulphide-filming I have found the microscope especially valuable for noting the efficiency of various filming methods. Material that is sized between close limits lends itself more readily to a microscopic examination than unsized material. Very often a slight panning in a watch glass will aid. Material through 260-mesh can readily be examined if the fines are removed by panning.

Numerous articles have appeared from time to time on the use of the microscope in petrography, metallography and qualitative chemistry, but no mention has been made of its use in ore-dressing.

The microscope can be used to advantage for at least four purposes, namely:

1. The determination of the mineral constituency of an ore that has been crushed.
2. In conjunction with a set of standard sieves for the determination of the critical diameter of an ore (the diameter of grain that shows all free mineral, no middling).
3. In obtaining an approximate analysis of the products of various concentrating machines.
4. Measuring the size opening in screens.

In explaining the above uses the subject will be discussed under the following heads:

- a. Instrument used.
- b. Source of light.
- c. Magnification.
- d. Methods of making determinations.

a. *Instrument Used.* The instrument used is the Bausch and Lomb metallurgical microscope with mechanical stage. Any instrument could be used, but there is a decided advantage in using the mechanical stage having lateral movement in two directions as well as vertical movement. The binocular microscope is good for comparing specimens.

b. *Source of Light.* Good sunlight has an advantage over artificial light and is best reflected upon the material from above, as light from below does not give good illumination. If the day is dark, it is best to use artificial light. The strength of light needed is determined by the magnification used. A plain 60-watt lamp is best for low magnification; a Nernst or Leitz lamp with bull's-eye condenser for high magnification.

c. *Magnification.* Low magnification from about 20 to 80 diameters serves best for general purposes. In studying products from fine screens and fine products in general, higher magnification is better. A little practice in this work soon determines what combination of lenses it is best to use.

d. Methods:

1. *Mineralogical Analysis.* For this work the ore is panned and dried; both products are put on small watch-glasses, placed under the microscope and the light adjusted. It is very easy for one with a knowledge of mineralogy to distinguish minerals, at least the more common ones as galena, blende, quartz, calcite, etc. With a little work one could be able to distinguish a larger variety. The knowledge of the ore gained by this analysis will aid more in working out various mill processes than will any qualitative chemical analysis or mineralogical analysis of the lump ore.

2. *Critical Size.* In this determination the procedure is more tedious, as a screen analysis followed by a

thorough microscopic analysis is required. The operation is as follows: After making the screen analysis take the product from each screen, mix intimately, place on a small glass slide under the microscope and make all adjustments. By careful examination the mesh at which all the particles of valuable mineral are set free from gangue and from each other can be determined, and, by counting, one can determine the ratio of these particles on each screen.

3. *Approximate Analysis.* Take a sample of the various products such as head, concentrate, middling, or tailing while the machine is working, place on a watch-glass and examine while wet for a hurried result, or dry on a hot-bath for a more careful study. In a very few minutes one can note exactly what work a machine is doing by noting the ratio of gangue particles to particles of valuable minerals.

4. *Measuring Screens.* By placing the screen to be measured under the microscope and using a calibrated Filar micrometer one can very quickly determine the diameter of the hole and the wire as well as the character of the wire. Very often a screen with supposedly square openings shows holes that are of many different shapes.

Of the above methods suggested the approximate analysis of products from concentrating machines offers the largest field for the use of the microscope because here the instrument is a time saver for the experimenter as well as for the chemist. The products to be examined include sands and slimes from various types of machines such as tables, vanners, stamps, fine crushers and flotation machines.

Flotation offers a very big field, for in testing the amenability of certain ores to the process, we must determine the effect of numerous variables, including the effect of hundreds of oils. In testing, as well as in actual working machines, we get a froth which is the concentrate. This froth is very deceptive as to its mineral worth and without a microscope a visual analysis does not always suffice, so when a microscope is not available it is necessary for the chemist to make the proper determination. In testing an ore the chemist will have some 500 to 1000 determinations to make, 80 per cent of which could be eliminated by the use of a microscope. Not only could a large part of the chemical analysis be done away with but the experimenter in examining the froths could study more closely the work of the machine and the nature of the process.

The testing with a microscope is only the work of a few minutes and can be done on the wet ore if the results need not be accurate; or upon the dry ore if a more accurate check is desired. The manipulation is as outlined under method number three.

It is to be remembered that this work is only as accurate as the operator makes it, the degree of accuracy of course being limited and depending upon the experience of the operator.

The above suggestions as to the uses of the microscope in ore dressing are not by any means all new ones, but it is hoped that these may prove interesting as well as useful to those who are less familiar with the microscope.

CHAS. Y. CLAYTON.

Missouri School of Mines and Metallurgy,
Rolla, Mo.

Copper in Converter Slags

To the Editor of *Chemical & Metallurgical Engineering*

SIR—The editorial in the April 15 number of METALLURGICAL AND CHEMICAL ENGINEERING on "Copper in Converter Slags," is very interesting, and one that should bring out some discussion from metallurgists who have to solve the problem of cleaning converter slags.

I herewith give the results of some experiments made by me on the pouring of converter slags into blast furnace settlers which may be of interest.

	Copper Per Cent
Experiment No. 1.	
Furnace and converter slag, proportions 1:1 assay	0.61
Furnace slag alone	0.31
Difference	0.30
Experiment No. 2.	
Furnace and converter slag, proportions 2:1, assay	0.53
Furnace slag alone	0.41
Difference	0.12
Experiment No. 3.	
Furnace and converter slag, proportions 3:1, assay	0.54
Furnace slag alone	0.40
Difference	0.14
Experiment No. 4.	
Furnace and converter slag, proportions 4:1, assay	0.63
Furnace slag alone	0.47
Difference	0.16

These experiments were checked several times, and showed that the converter slag was not cleaned below approximately 1 per cent copper by this method which together with the fact that the excess iron contained was valuable as a flux, finally resulted in all the converter slag being resmelted in the blast furnaces, the limestone being taken off the charge, and both costs per ton of charge and metallurgical losses materially reduced. At first the converter slag was spilled on the ground and picked up by hand labor, but this was afterwards changed to simply spilling it in thin layers on the ore in the pits as the beds were being built for smelting, the plant lending itself peculiarly to this method of handling the slag.

Most metallurgists will, I think, admit that converter slags cannot be cleaned without resmelting them, and in doing so, changing the chemical composition, but it will be interesting to get the experience of those who have had to treat them by other methods and especially of those who, on account of their plants are forced to spill the slag into reverberatory furnaces.

FOREST RUTHERFORD.

New York City

[We invite further discussion of this interesting subject.—EDITOR.]

Condensation in Electric Zinc Smelting

To the Editor of *Chemical & Metallurgical Engineering*

SIR—In your issue of May 15, 1918, page 540, in the article on Fulton's Electric Zinc Furnace, the following didactic statement is made: "Several designs of electric zinc furnaces can produce zinc vapor in large quantity, but none of them has been able to produce the proper yield in liquid metal." I have no knowledge of how inclusive the said "several designs" may be; but

as the evident intent is to convey the impression that the Fulton furnace, or its condenser, is the first to successfully accomplish the indicated result, I beg the privilege of informing you that this is not in accordance with the facts.

For some ten or more years past, I have been engaged as a principal in the design and development of electric furnaces for reducing zinc ores, complex and oxidized, the principal work being carried on in Europe, or until suspended by the war. Hundreds of tons of high-grade zinc was produced, the condensation being approximately completely in the form of liquid metal. The reduction was according to the classical formula



More recently, or about two years ago, I designed and caused to be built and operated an electric furnace and condenser for refining impure spelter by re-distillation. The overall dimensions of this unit, in plan, were about 5 x 8 feet, height 4 feet, and it was run for months continuously with a regular output in refined zinc of 2,500 pounds in 24-hours, and in one case at the rate of 3,600 pounds. The condensation was complete to liquid metal.

Incidentally, the upkeep cost was *nil*. The electric energy required for this operation ran from about 0.5 to 0.6 kw.-hr. per pound of refined metal and in a regular "going" operation could probably be reduced to 0.4 kw.-hr., which is sufficiently near to the theoretical limit, as in "the books," to be dubbed good enough.

That the work was carried through with care, skill and intelligence, and with a docket record which is complete, goes without saying in that it was conducted by Mr. F. A. J. FitzGerald, E.E., at his laboratories, Niagara Falls, N. Y.

The project, as relates to zinc-smelting, has not as yet been exploited in this country, nor am I seeking by this means to advertise it; the limited details herein set forth are presented simply to accentuate the point that a little *condensation* of such a sweeping statement as you stand sponsor for would appear to be in order in the interest of accuracy and fairness.

JOHN THOMSON.

New York City

Special Gold-Recovery Processes

To the Editor of Chemical & Metallurgical Engineering

SIR—In your issue of June 1 Mr. Kirby Thomas calls attention to the fact, reported by John Mawe a century ago, that Brazilian natives mixed the juice of certain bruised herbs with the water in which they finished the panning of gold from black sand, and also mentions the addition of the leaves of an oak-like tree to *tahones*, or primitive Chilean mills, used for grinding ore in Sinaloa, Mexico. This use of plant juice to facilitate the settling or concentration of "float" gold has been mentioned by several other writers.

Volume 20 of the Proceedings of the Institution of Mining and Metallurgy (1911) contains two papers on the Passagem and Ouro Preto mines in the province of Minas Geraes, Brazil. One of these, by R. H. Kendall, describes (pp. 28-60) the modern treatment of the bismuthic gold ore of Ouro Preto by stamp-milling and concentration on blankets followed by Frue van-ners. The very rich blanket concentrate (largely free

gold) is re-washed over a small blanket, yielding a final concentrate carrying about 80 per cent gold. "The water used in this operation is a solution containing the juices of the leaves of the *jurupeba*, and is very effective in preventing float gold. . . . At the end of each day's operation the *jurupeba* solution is filtered off by suction and stored for next day."

In discussing this paper, H. L. Sulman, president of the Institution, called attention to the use of this herb—presumably containing saponin—which he interpreted as reducing the surface tension of water. Sulman, by the way, was an oil and soap chemist and an early experimenter in flotation, who had previously patented the use of soap solution for settling float gold and slime (Brit. pat. 24,939, of 1893 and 8,405 of 1894). The plant was stated to be *Solanum paniculatum*, of the nightshade or potato family, and also locally called *herva de sabão* (soap plant). Other plants, including a variety of passion-flower, were also said to be employed for the same purpose in the district referred to above.

The same thing had also been recorded by Alexander Calcleugh ("Travels in South America, 1819-1821"; published in London, 1825). A. G. Lock ("Gold", p. 227) says: "The overseer showed Calcleugh some plants whose juice is squeezed into the bowls containing gold, to carry down the lighter particles. There were several plants in common use for this purpose, but the one generally preferred, from its containing more juice, was called *itabamba*; it appeared to be a *Solanum*. The leaves had a bitter taste and gummy feel." This was at a place one league from Passagem.

In the Philippine Islands a pod-bearing vine (*Entada Purusaetha* or *Entada scandens*, called *gogo* or *balogo* by the natives) is used in panning gold with the *batea*. This contains saponin and was the subject of an investigation and report by the Philippine Bureau of Science a few years ago. It was also mentioned by Lock ("Gold", p. 368).

Something similar has, I believe, been reported as used by the native gold-washers of Sarawak (Borneo) and Sumatra; I have also heard vaguely of an herb used by Mexicans in California and Lower California. The latter is probably one of several well known liliaceous plants called soap-root or *amolè*, the roots of which contain enough saponin or allied substance to lather freely with water.

Saponin as an anti-flotative agent has been discussed to some extent by Hoover, Rickard, and other writers on flotation. It evidently occurs in plants differing widely in character and distribution, which include the horse-chestnut and the numerous soap-roots, soap-barks, soap-berries, etc. Its application to float gold appears from the above to be confined to people of a relatively low stage of civilization. It would be interesting to ascertain whether such remote races as the Brazilians and Filipinos discovered it independently, or whether, as Mr. Thomas suggests by the heading of his letter, they both learned its use from the early Portuguese or Spaniards who employed them in mining. That it "works" is evident from its continued use in Brazil for a hundred years.

W. J. SHARWOOD.

Homestake Mine.
Lead, S. Dakota

Western Metallurgical and Chemical Field

Price Fixing in Zinc, Copper and Aluminium

THE President has approved various agreements entered into between the price-fixing committee of the War Industries Board and interested producers and consumers. Prices on grade A zinc are continued at 12 cents per pound, f.o.b. East St. Louis until Sept. 1, 1918, while 14 cents per pound f.o.b. plant for plate zinc more than $\frac{1}{8}$ inch thick and 15 cents per pound for sheet zinc subject to the usual trade discounts and extras in effect Feb. 13, 1918, will be the official price until the same date. The expectation of the miners and producers of prime western that a price of 11 cents would be fixed for second grade zinc was thus disappointed.

Following is the specification for spelter for navy requirements, as announced by the Government:

SLAB ZINC

GENERAL SPECIFICATIONS

1. General specifications for inspection of material, issued by the navy department, in effect at date of opening of bids, shall form part of these specifications.

GRADES

2. There shall be three grades of spelter, grades A, B and C, respectively, conforming to the requirements stated below.

QUALITY

3. "Only virgin spelter, that is, spelter made from ore by a process of direct reduction and distillation, redistillation, electrolysis or a combination of the above shall be furnished in grades A and B. Metal produced by the refining of by-products such as brass mill wastes or other by-products resulting from the manufacture of non-ferrous alloys or similar materials, will not be accepted under Grades A and B."

CHEMICAL REQUIREMENTS

4. The chemical properties of the several grades of slab zinc shall be as follows:

GRADE A

	Per Cent
Zinc, minimum	99.85
Cadmium, maximum .....	.05
Iron, maximum .....	.03
Lead, maximum .....	.07
Sum of cadmium, iron and lead, maximum .....	.10
Aluminium, maximum	None
Other elements—tin, arsenic, sulphur, antimony, etc.	None

GRADE B

	Per Cent
Zinc, minimum	99.35
Cadmium, maximum .....	.50
Iron, maximum .....	.03
Lead, maximum .....	.20
Sum of the cadmium, iron and lead, maximum ..	.50
Aluminium maximum	None
Other elements—tin, arsenic, sulphur, antimony, etc.	Traces

GRADE C

	Per Cent
Zinc, minimum	98.00
Cadmium, maximum .....	.75
Iron, maximum .....	.08
Lead, maximum	1.00
Sum of cadmium, iron and lead, maximum	1.50
Aluminium	Traces
Other elements—tin, arsenic, sulphur, antimony, etc.	Traces

The War Industries Board advanced the price of copper to 26c. on July 2. Where contracts for brass tubings, wire, etc., had been made at the 23½c. figure the old prices should prevail until August 15.

A new price for aluminium, effective from June 1 to Sept. 1, 1918, is 33 cents per pound, f.o.b. smelter, 93 to 99 per cent ingot, in lots of 50 tons or over. Differentials for quantity, grade, and alloys remain as before, while differentials for sheets, rods, and wire are increased approximately 12½ per cent.

Work of the Colorado Station of the Bureau of Mines

During the past year at the Bureau of Mines' Experiment Station at the State School of Mines, Golden, Colorado, under the direction of R. B. MOORE, the coöperative work in connection with the National Radium Institute has been completed, and over eight and one-half grams of radium element recovered. The larger part of this radium goes to the officials of the National Radium Institute, who will use it for cancer work. Part of the balance was retained as its share of the work and will be held at the Colorado station for scientific research; a part was presented to the Bureau of Standards, and the rest of it will be at the call of the Army or Navy hospitals. This coöperative work has given the Bureau an excellent opportunity to study the technical and scientific problems connected with the manufacture of radium from carnotite ore.

In addition to carnotite, another uranium mineral, pitchblende, is found in appreciable quantities on Quartz Hill, near Central City, Colo. Two of the mines were formerly owned by Mr. A. I. DuPont, and during his operations a considerable amount of ore was mined and this was ultimately turned over to the Bureau of Mines under a coöperative agreement for experimental purposes. The material was used for a thorough investigation of the best methods of concentration of the low-grade ores and the extraction of radium and uranium. The solubility of radium sulphate in water and in different concentrations of sulphuric acid has been determined, and the results published. This work has a distinct bearing on the precipitation of radium from solutions in plant operations.

The recovery of two other radioactive elements—ionium and actinium—from radium-bearing ores is also being investigated. If these elements could be produced commercially along with radium, they could be substituted for radium in luminous paint, and in other ways. A redetermination of the ratio of radium to uranium in primary uranium minerals will be started shortly. This will have a bearing on the whole question of radium recoveries in the treatment of radium ores, as well as a very definite scientific value.

Many manganese ores carrying silver cannot successfully be treated by cyanidation, the extraction of the silver being altogether too low. Under a coöperative agreement with the Dutch government, a thorough investigation of the treatment of certain of these ores by means of the Caron process is now being carried out. This process involves a preliminary reducing roast, by which the silver extraction can be raised and a satisfactory recovery obtained by cyanidation. It is probable that the scope of this investigation will take up the whole question of leaching manganese ores, and the re-precipitation of the manganese.

Under a coöperative arrangement with the Welsbach Company mesothorium is being investigated, and a

method for the recovery of this element as a by-product in their manufacture of thorium nitrate has been worked out. This mesothorium, which has in the past gone to waste, will ultimately be used for luminous paints for various objects, such as instrument dials, as well as for therapeutic purposes.

The Colorado Station has been particularly interested in molybdenum, and has not only worked on a soluble molybdenum ore from near Ouray, both as regards its composition and treatment, but also has been interested in the concentration and metallurgy of wulfenite and methods of separating molybdenite from copper-bearing minerals. The best conditions for the reduction of tungstic acid to metallic tungsten have been worked out, and results will shortly be published. Work has also recently been started on the metallurgy of certain vanadium minerals, such as vanadinite and cupro-desclowitzite.

A Tariff or a Bounty on Antimony

The difficulty in imposing a rational tariff on antimony according to the rule—cost of foreign production plus tariff equals American cost—is glimpsed when one understands that the cost of Chinese antimony is unknown except perhaps to the Chinese (and they are not telling), while American mining and smelting are both in such an embryonic condition that even the potential operators do not know what it will cost them on a basis of quantity output. Certain it is that the price of Chinese antimony has fluctuated over such wide ranges in the past years that one suspects speculation by brokers or else market manipulation by those controlling the bulk of the supply. A successful corner in a metal so widespread and so easily won as is antimony, appears to be improbable; on the other hand, more than once in the past 25 years have western miners been enticed by high antimony prices to get small properties to the production stage, then only to find a prohibitively low price.

As is natural at any tariff hearing, many divergent views were expressed by those present at a recent conference with the Tariff Commission in San Francisco. All present (except the importer of Chinese metal) agreed that American antimony could be produced in sufficient quantity at 16 cents; on this basis the miner could receive \$85 a ton for a 50 per cent concentrate, leaving 7½ cents per pound to cover the cost of smelting and selling the metal. This latter item is said actually to cost 5½ to 6 cents at the Los Angeles works of the Western Metals Company. The miner was careful to emphasize, however, that a sufficient tariff wall should be erected against the importation of ore, else by treating cheap foreign ore the smelter would reap all the benefit and the miner none.

The United States' consumption of antimony is moderate. Pre-war requirements amounted to about 7000 tons of metal per year, of which 3000 tons were produced as a byproduct of the refining of antimonial-lead. It is largely used for hardening lead—in the manufacture of bullets, bearing metal and type metal. The present consumption has doubled the demand; it now probably amounts to about 1500 tons per month.

From the facts just indicated, i.e., ignorance of actual production costs, the moderate amount required of this very widespread metal, and its acknowledged impor-

tance in munitions, the tariff commission may with reason recommend that the War Industries Board solve the riddle by offering to purchase for a period of years the munition requirements of American made metal from American ores at a price covering cost plus a reasonable profit. During that time the operations of this industry, then passed from embryonic to the infant stage, can be studied and proper measures taken to insure its continuance.

Company Reports

Inspiration Consolidated Copper Company.—Notwithstanding a strike lasting two months, and a considerably reduced scale of operations for the remainder of the year, Inspiration mined 3,914,742 tons of ores from which 80,566,982 pounds of refined copper was produced, which netted an average price of 26.366 cents. The cost of production, exclusive of depreciation and federal income tax, is tabulated as follows:

	Cost per Lb.	Cost per Ton
Mining.....	3.572c.	\$0.7239
Coarse crushing.....	0.163	.0329
Ore hauling.....	0.101	.0206
Concentrating and royalty.....	2.931	.5941
Concentrates hauling.....	0.007	.0015
Smelting, freight, refining and marketing.....	3.665	.6369
Total.....	10.439c.	\$2.0099

The grade of the ore was purposely dropped to 1.388 per cent copper, containing 0.279 per cent oxide copper, from which 20.39 pounds of copper was recovered. This recovery figures to a little over 75 per cent of all copper, but nearly 90 per cent on the sulphides contained. Important experimental work to increase this recovery was continued, indicating the desirability of retreating sand and slime separately, floating the sulphides from the former followed by a roasting and leaching operation similar to that practiced at Anaconda. The slime, containing a large proportion of the oxides, is to be leached with sulphuric acid. The success of the Ajo plant of the New Cornelia Copper Company treating ores very similar to the 20 million tons of oxides on Inspiration ground seems to settle the question of treatment of these reserves. During the year a new chemical laboratory was constructed at the concentrator, the filter plant was increased 50 per cent, a 200-ft. concrete tank for tailing settlement built, and two additional units added to the mill.

Additional data on the operation of the mill follow:

Water Consumption for First Six Months of Year per Ton Ore Milled:		Gal.
Reclaimed in tanks at foot of mill.....		356
Reclaimed in tailings ponds.....		475
New water from Kiser pump station.....		277
		1,108
Power Used per Ton Ore Milled for First Six Months of Year:		Kw.-Hr.
Coarse crushing.....		.43
Fine grinding and concentrating.....		10.87
Blowers for flotation air.....		2.42
Filter and reclaiming water.....		2.01
Lights.....		.07
Total.....		15.80
Steel ball consumption in fine grinding, per ton ore milled (for year).....		1.82 lb.
Flotation Oils per Ton Ore Milled:		
Coal tar—lb.....	1.21	
Sundry oils—lb.....	.11	1.32 lb.

Phelps Dodge Corporation.—The concentrator at the Morenci branch treated 312,224 tons of ore containing 2.333 per cent copper, producing concentrates averaging 11.201 per cent copper, and a tailing averaging 0.648 per cent copper, a saving of 71 per cent, on a concentration ratio of 6.78. The metallurgical results here are unsatisfactory owing to inefficient labor, and

irregular and inadequate power, the mill having operated but 54 per cent of the time. An extension to the flotation department is under way, which is designed to increase the savings. Somewhat the same metallurgical conditions obtain at the mill of the Moctezuma Copper Co., where 750,897 tons of ore containing 3.179 per cent copper were treated producing a tailing of 0.747 per cent copper—a saving of 81 per cent. These operations were uninterrupted throughout the year, however, and the net production of 38,186,451 pounds of copper exceeded the previous maximum by over two million pounds of copper. Experimental work is to be continued on the slime, together with other tests to reduce loss in sand-tailing by fine grinding. At the Bunker Hill mines, Tombstone, Arizona, experimental work for the treatment of low-grade gold-silver-lead ores by flotation was unsuccessful owing to high operating costs and poor extraction. Half the mill capacity was used in making manganese dioxide concentrates, which operation produced a silver-bearing tailing suitable for flux. Eleven tons of wulfenite concentrates carrying 2106 pounds of molybdenum were also shipped. Labor troubles in the Bisbee district did not affect the production of the Copper Queen smelter at Douglass, owing to the stocks on hand and the increased shipments from Burro Mountain, Moctezuma, and the United Verde Extension, so that the total output shown below was the largest in its history by a margin of almost 20 million pounds.

	Dry Tons Charged	Ounces Gold	Ounces Silver	Pounds Copper
Copper Queen branch.....	794,904	19,171	550,156	87,831,317
Burro Mt. branch.....	45,868	293	36,799	13,342,508
Moctezuma Copper Co.....	167,381	1,910	508,387	38,499,781
All other.....	268,664	10,957	946,921	51,907,525
Total, 1917.....	1,276,817	32,331	2,042,263	191,581,131

Offerings of custom ores were more than could be accepted. Minor changes in the various departments are expected to increase substantially the capacity during 1917. The record production of copper was effected with but one fatal accident in the smelting departments.

Judge Mining and Smelting Co.—The mill at Park City, Utah, treated 63,387 tons of ore in 501 shifts, producing 11,861 tons of lead concentrates and 5526 tons of zinc concentrates. The electrolytic zinc plant has been continuously and successfully operated since the start, early in the year. The production has been small, however, owing to the impossibility of obtaining desired reagents for the purification of the solutions. This difficulty has been largely eliminated by changes in methods employed, and with a good price fixed for Grade A zinc, production should proceed at the designed capacity.

Goldfield Consolidated Mines Co.—The activity of this company is summarized as follows: 250,550 tons of ore was treated, containing \$2,039,103 in metal value, and yielding \$1,762,970; and 81,885 tons of tailings containing \$103,843, of which \$62,326 was recovered. Two-thirds of this production was cyanided, and the balance treated by the flotation process. The latter, operating on low-grade copper ores, has been in continuous service since opening in March. The concentrates are now shipped to custom smelters, since three months' experience with a local concentrate-treatment plant proved unsatisfactory, and tests indicated that they cannot profit-

ably be cyanided without a chloridizing roast. The company has opened a store for the purpose of reducing the cost of living, with pronounced success and unqualified approval from the employees. All business is conducted on a cash basis, and a preferential discount of 10 per cent given to employees. The cost of operation including the discount is 19 per cent. of the total sales, and the department sustained a loss of \$4000 in ten months' operation. The appended tabulation shows very graphically the trend of the company's operations, and about the middle of the year it became apparent that the ore exposed would not yield a profit. Later development work is distinctly encouraging, however. Nevertheless a statement of recoverable assets and the scrap value of the equipment after operations have ceased includes the following items:

Scrap value of plant.....	\$250,000
Mill clean-up.....	100,000
Profit from subsidiary.....	300,000
Profit from mine.....	200,000
Profit from tailings.....	500,000
Supplies and stores.....	530,000
Cash and investments.....	551,000
Total.....	\$2,431,000

which could be realized during a period of about six years. The following comparative data are interesting:

	Average Recovery	Average Cost	Net
Year ending Oct. 31, 1909.....	\$34.72	\$8.88	\$25.84
Year ending Oct. 31, 1910.....	38.50	10.97	27.53
Year ending Oct. 31, 1911.....	30.74	7.97	22.77
14 mos. ending Dec. 31, 1912.....	18.40	6.65	11.75
Year ending Dec. 31, 1913.....	14.14	6.32	7.82
Year ending Dec. 31, 1914.....	11.61	6.19	5.42
Year ending Dec. 31, 1915.....	9.01	5.02	3.99
Year ending Dec. 31, 1916.....	6.53	5.18	1.34
Year ending Dec. 31, 1917.....	7.04	6.01	.68

The Consolidated Mining and Smelting Company of Canada, Ltd.—Reminders of the recent acute state of the Canadian lead market are contained in the report of this company, operating the Trail smelter, showing a large bank overdraft (\$2,081,806.24) which the president of the company, Mr. W. D. MATTHEWS, states is due to the unusual accumulation of ores in anticipation of the needs of the Imperial Munitions Board. Overbalancing this is metalliferous material valued at \$2,615,664.17, subdivided as follows: Pig lead on hand and in transit to refineries, \$29,242.95; ores on hand, \$1,502,698.20; refinery metals on hand, \$1,014,819.10, and ore in transit to smelter, \$68,903.92. The last year has been one of extraordinarily diversified activities at the smelter, the construction ending Sept. 30, 1917, totalling \$1,442,883.12. The electrolytic zinc plant was completed, and a daily production of over 60 tons of pure zinc reached, while a 400-ton concentrator was erected to treat the Sullivan ores. In the lead plant the new bedding system was completed, and a record production of 22,133 tons metal attained with the best metallurgical results in recent years. The sulphuric acid plant was doubled in capacity, and now produces thirty tons of chamber acid per day. After supplying the entire needs of the refineries and the zinc plant, there is a surplus for commercial sale. The hydrofluosilicic acid plant produced 196 tons of 100 per cent acid, providing the entire requirements of the lead refinery. Two new retorts are now under construction, to double the capacity of this plant. Taking these departments into consideration, the Trail plant is producing on a commercial scale bluestone, sulphuric acid, hydrofluosilicic acid, gold, silver, copper, lead and zinc.

The President's Readjustment and Reconstruction Commission—III

BY WINGROVE BATHON

Washington Correspondent, McGraw-Hill Co., Inc.

FOLLOWING the presentation in McGraw-Hill Engineering Publications of a concrete plan for a proposed Readjustment and Reconstruction Commission to be appointed *now* by the President of the United States, to deal *now* with problems which will be presented to American Industry after the war, it has become known in Washington administrative circles, in an unofficial manner, that a plan for a readjustment and reconstruction agency is under consideration.

COUNCIL OF NATIONAL DEFENSE STUDYING PROBLEM

It is permitted to say here publicly for the first time that the Council of National Defense has been studying the subject of readjustment and reconstruction for a lengthy period, with a view to co-ordinating various Government activities in Washington which have had readjustment and reconstruction for their object. When President Wilson recently set up the War Industries Board, under the chairmanship of Mr. Bernard M. Baruch, as a separate agency, divorcing it from the Council of National Defense, the latter organization was left with but little work to do, and with but few prominent men remaining in its personnel. There is reason for the belief that the Council of National Defense has resolved to undertake the work of readjustment and reconstruction, if permitted to do so by President Wilson, and there is also reason for the belief that the President will assent, under the urging of Secretary Baker of the War Department, chairman of the Council, acting in behalf of himself and the other five members of President Wilson's cabinet who compose the Council of National Defense.

In Washington official circles there is an impression that this would be a logical step, inasmuch as a number of cabinet officials have begun making public details of readjustment and reconstruction ideals upon which their own departments and bureaus have been separately at work, following the advocacy of such a readjustment and reconstruction agency in McGraw-Hill Engineering Publications. There is ground also in Washington not only for the impression but for the strong belief that if the Council of National Defense is authorized by the President to begin work on readjustment and reconstruction problems, W. S. Gifford, Director of the Council, will not only set to work at once to co-ordinate all the work being separately done in the various departments but will undoubtedly call into consultation and activity at Washington men in private industry of the type suggested in the first article in this series which was put forth as a method of crystallizing opinion in favor of a readjustment and reconstruction agency and obtaining action to create one. In other words, it is in expectation in Washington that, if the President assents, the Council of National Defense will be newly created by the appointment of a large number of committees of important men of the type suggested in the first article in this series, taken from the ranks of private endeavor, to solve now the after-the-war industrial problems of this country, as England is now doing.

Before this is published, the question of what char-

acter of readjustment and reconstruction agency shall be established may have been settled. It is possible that when the announcement of the Government's intentions in this respect is made, it will have been found after due consideration that it might be more wise to commit the work of readjustment and reconstruction to an agency other than the Council of National Defense; but the subject is now being discussed on all sides in Washington, and letters and telegrams from all over the country are being received in Washington urging the creation of such an agency at once.

From Philip H. Gadsden, chairman of the National Committee on Public Utility Conditions, comes a letter strongly indorsing the idea of action. The National Committee on Public Utility Conditions, which includes E. K. Hall, H. H. Crowell and A. S. Hills, executive secretary, represents in Washington the National Electric Light Association, the American Electric Railway Association, the American Gas Institute, and the National Commercial Gas Association. Mr. Gadsden says:

"It is coming, I think, to be more and more generally realized that the problems which the industrial world will have to face after the war in the readjustment of our economic life will be more serious than even the problems which we are now called upon to meet. Your suggestion, therefore, that the President at this time appoint a Commission on Readjustment and Reconstruction, in my judgment, is a very timely one.

"The great lesson which this war has impressed upon every one is the efficiency resulting from great concentration of capital and labor. The benefits derived by the nation for war purposes in the mobilization of practically all the industries of the country will not be lost sight of when peace comes. To deal properly with such a radical change in our economic policy will call for all the wisdom at our command. Nothing could aid so much in the proper solution of such a problem as a thorough and comprehensive study of it in advance, such as you suggest."

From the Permutit Company, engaged in water rectification and general sanitation, New York, comes this letter, signed by Samuel Robert, President of the Company:

"As we see it, there can hardly be room for doubt as to both the usefulness, and, indeed, the necessity, for the work of the nature referred to, and that this work should be done as quickly and as thoroughly as possible.

"We can think of no better way to prepare the ground work essential to the proper accomplishment of this vital project (vital to the future benefit of the industries of this great country) than by having a commission appointed as quickly as possible for the express purpose of investigating the necessary steps needed to prepare for its accomplishment, and then to put into effect as thoroughly as possible the means needed for its fulfillment. We are in hearty accord with this movement."

DEMANDS OF RECONSTRUCTION PERIOD NOT APPRECIATED

From Charles F. Lang, President of the Lakewood Engineering Company, Cleveland, Ohio, comes this letter:

"While our company is working night and day on war service for the Government, and is constantly endeavoring to expand its usefulness in this direction, all our planning is being done with a view to world-trade conditions after the war, for we feel that we but dimly realize the demands which world-trade will make upon American manufacturers in the reconstruction-period immediately following the war.

"And we also recognize the period of tremendous readjustment which must take place in our own country. National conditions and national ideals are entering a violent revolution rather than a slow evolution, and I sincerely trust that the very constructive program suggested by you will receive serious consideration and prompt action on the part of the Government; for the

problems involved are not merely national, but world problems; and individual thinking by individual business men is hopeless—the nation must think and plan *as a Nation*."

From the great merchandising house of William Filene Sons Company, Boston, Mass., comes this letter, signed by Edward A. Filene, its President, who is Chairman of the War Shipping Committee of the Chamber of Commerce of the United States:

"I am in entire agreement with your suggestion that such preparation should be under way. Unless there is created a Governmental Agency for this undertaking, an agency thoroughly representative of all classes and interests, these problems will be taken up separately by the various classes and interests."

UNITY OF PURPOSE VITAL TO WELFARE OF COUNTRY

"If the bulk of the reconstruction planning is left to separate classes and interests, we shall come to the end of the war with a series of reconstruction programs. Business will have a program; labor will have a program; agricultural interests will have a program; banking interests will have a program; socialists and holders of relating theories will have a program. And, at the very moment when unity of purpose and promptness of action will be vital to the welfare of the country, we shall be obliged to pay the price of costly delay incident to the harmonizing of these several programs of reconstruction."

"It is clearly the wise policy to create a government commission so thoroughly representative of all classes and interests that it will command the support of all classes and interests. If such a commission collates its facts, formulates its conclusions, and submits them in advance to the most exhaustive criticism from all possible angles, we shall be able to get most of the work of compromise out of the way by the end of the war and arrive at the time of action with a unity of purpose and policy otherwise impossible."

"I realize the question of tactics and timeliness involved in any proposal today not related to the immediate job of prosecuting the war; and yet, the war will end some day, and whether that time be one year or twenty years from now, the time will be none too long for the analysis of the complicated problems that underlie the return of our social, industrial, and political life from a war basis."

Fourth National Exposition of Chemical Industries

THE Fourth National Exposition of Chemical Industries will be held in the Grand Central Palace, New York, during the week of Sept. 23 this year. The advisory committee is composed of Charles H. Herty, chairman; Raymond F. Bacon, L. H. Baekeland, Elwood Hendrick, Henry B. Faber, Bernard C. Heese, A. D. Little, Wm. H. Nichols, R. P. Perry, H. C. Parmelee, G. W. Thompson, F. J. Tone, T. B. Wagner and M. C. Whitaker. Dr. Bacon of this committee is now head of the Chemical Warfare Section of the National Army and a member of General Pershing's staff.

The coming exposition will be the largest chemical exposition ever held and it will be necessary to use four floors of the Grand Central Palace. Regarding the exposition as a war-time necessity, each exhibitor is planning an exhibit that will be of the greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities, and constantly increasing this production till the war has been won by the United States and its Allies.

The amount of floor space already engaged is greater than last year; the exhibits will be much more attractive and a movement is under way to show all exhibits of machinery in operation under actual working conditions

as they would be found in the field. The products of chemical manufacturing as they enter into the world's commerce will be shown as examples of what the chemist has produced in America since the world war began.

The South is again sending exhibits from some sections, and Canada, too, is taking the opportunity of presenting the materials it has available for development by the chemist and financier. Technical and business men over the country give heed to these exhibits since they will show how they can meet the war-time need. A section for the glass and ceramic industry has been added with which the American Ceramic Society is co-operating.

The program for the exposition is in active preparation and will be a series of symposia on the "Development of Chemical Industries in the United States, notably since July, 1914." This will embrace the period since the beginning of the European war, which by removing the source of supply for some of our domestic industries has inspired the development of our own chemical industry. The program of motion pictures carries forward the idea of the symposia.

War Industries Board Plans Conservation of Tin

THE plan upon which the War Industries Board is working for the conservation of tin is based on the conviction that no government official, department or bureau can be in position to apply restrictions to industries as wisely as the men who have spent their lives in the industries affected and are thoroughly acquainted with the technical details and the business consequences involved.

The Board calls meetings of representatives of each important trade using tin, states the necessity for economy, asks for patriotic coöperation and seeks advice as to how to get the results desired. Each industry is asked to organize, to consider the problem and submit specific recommendations. These recommendations are digested and sent to everyone in each trade concerned. Conferences are held with those who may not agree with the recommendations so as to get as complete unanimity as possible. A set of recommendations or regulations is then drawn up for each industry and these are enforced by the authority of the War Industries Board.

The various uses of tin by different trades are classified in an ascending scale of importance.

First: Wasteful uses due to carelessness, ignorance or indifference. Wastes due to faulty practice which might be cut off not only without injury to anybody but rather to the definite pecuniary advantage of manufacturers.

Second: Uses non-essential in character, such as the coating of articles with tin for ornamental purposes solely. Uses which could be cut off without injury to any individual or firm, provided all acted alike.

Third: The employment of tin for purposes which in themselves are useful and desirable, so that their elimination would involve a certain amount of sacrifice on the part of manufacturers or consumers; but which are in no way connected with the vital needs of the country in relation to the war.

Fourth: Uses directly for war purposes either by the

Government itself as a manufacturer of war materials or by manufacturers who are making war materials for the Government.

Uses under "first" and "second" can and should be cut off at once. Under "third" curtailment is not in itself desirable. It will result in a certain disorganization of industry and reduction in economic efficiency and ought to be avoided if possible. But the sacrifice will probably have to be made. Lastly, come the direct war requirements, which must be met in full or military efficiency will suffer.

The following results have already been accomplished:

1. SOLDER AND BEARING-METALS

Standardizing. There are scores of compositions used in bearings-metals and solder. The Bureau of Standards has completed an investigation of bearing metals and has suggested elimination of all but four grades. This recommendation was adopted by the meeting and it is stated that a saving of about 25 per cent in amount of tin will be effected. The Bureau of Standards is making similar investigations concerning solder. The can companies have reduced the percentage of tin in their solder to forty, thus saving from 8 per cent to 10 per cent without injury to the industry.

2. BRASS AND BRONZE INGOTS AND CASTINGS

Most of this business is directly or indirectly for Government account. Considerable reduction could be made in tin content without reduction of efficiency. Large savings have already been made by automobile and other machine manufacturers by substituting for all metal bearings, case bearings with thin lining shell ($\frac{1}{16}$ in. to $\frac{3}{32}$ in.) of high-grade babbitt. Straits tin is often specified on the assumption that it is the purest tin. Banca is even purer than Straits or Australian, and electrolytic tin is as pure.

Manufacturers of tinfoil and collapsible tin tubes have effected large savings by reducing the tin content, and by substitution of other materials for containers. A plan was suggested and is now being perfected for the recovery of a large part of the tin used in foil and tubes. Through a campaign of advertising, through notices on the packages, and other methods, consumers of articles packed in foil or tubes will be induced to save these articles and turn them in at the nearest Red Cross center as donations. Smelters and other users of tin will then purchase at market rates the lots thus collected by the Red Cross. It is estimated that this will recover some 3000 to 5000 tons of tin per annum, and bring the Red Cross an added income of from \$4,000,000 to \$5,000,000.

3. TIN PLATE

Plans for the conservation of tin plate have long been in the hands of the Committee on the Conservation of Tin Plate. In cooperation with the trades concerned large economies have already been effected. The manufacture of plate for many less-essential uses, such as roofing, for store boards, for fire doors, etc., has been eliminated by agreement. Tobacco manufacturers have just reached an agreement by which black plate will be substituted for tin plate for most tobacco cans, effecting a saving of probably 750,000 base boxes of tin plate per annum. In addition, the

quantity of plate required for export has been greatly curtailed by the regulations for the War Trade Board restricting export to plate which is to be used for specific war purposes.

Post-War Problems of the Electrochemical Industry

The American Electrochemical Society will hold its Fall meeting at Princeton, N. J., Sept. 29 to Oct. 1, and is planning to devote one session to a consideration of the reconstruction and post-war problems of the industry. The status of all our industries after the war is a most important question and deserves careful study at this time. This is especially true of many electrochemical industries which the demands of the war have stimulated to a point of expansion far beyond the requirements of peace.

Many of these industries such as the chlorine and alkali industry, the ferro-alloy industry, the manufacture of electric steel and the carbide industry have undergone an enormous expansion. We shall have the problem of the disposition of Government-owned plants. We must develop new uses in the arts of peace for the products of our war plants. Most all of these questions of reconstruction and readjustments are pressing in view of the world-wide competition which will follow a declaration of peace. Other subjects are the future of air nitrates, the electric power situation and research after the war in its varied university, Governmental and industrial phases.

A topic of far-reaching importance is the future relations of technical men to the affairs of Government. Can the very important work of some of our technical boards be continued after the war and made to function with the administrative and legislative branches of the Government?

How Great Britain is Handling Post-War Questions

The British Ministry of Reconstruction has just published a complete list of the various commissions and committees that have been set up, both within that ministry and within other ministries and departments of the British Government, to deal with questions which will arise at the close of the war. These commissions and committees, which have been appointed at different times since the war began, now number 87 and fall into 15 groups of which the following will be of interest to the metallurgical and chemical industries:

To create a committee representative of the chemical trades for the development of its own resources and the securing of co-operation of all engaged therein.

To consider the international competition to be expected in the metallurgical industries, and devise proper safeguards required to maintain their position.

To investigate various processes for nitrogen fixation, survey the raw materials required, investigate the production of cheap power, to carry out preliminary experimental work, and to advise as to proper conservation of nitrogenous compounds.

To consider carbonization of industrial and domestic fuel.

To institute research on the preparation and utilization of fuels.

To advise on research in metallurgy and glass making.

To investigate the preparation, properties and applications of abrasive and polishing powders.

To prepare a reference list of the composition, densities, and optical characteristics of vitreous compounds and cements for same.

To control researches in tin and tungsten.

To survey the lubrication field, institute research on problems involved, and to collect and review the chemistry of lubricants and oils.

To collect and review existing information on copper and zinc manufacture as a basis for future research, and to institute research into methods of making sound castings and brass tubing.

To formulate methods of improving permanently the relations between workmen and employers.

To advise as to the opportunities of post-war employment of women.

Federal Supervision of Niagara Falls Power

AS announced in this journal, Dec. 1, 1917, the War Department took over the supervision of the supply of electrical power at Niagara Falls in November, under the immediate direction of Robert J. Bulkley and Brig. Gen. Charles Keller. The first result of the supervision was to requisition for the United States all power generated or imported by the Hydraulic Power Company and the Niagara Falls Power Company, both of Niagara Falls, New York, and distribute it to war industries. The War Department now announces that as a result of this supervision accurate knowledge has been obtained of the use of power generated in this country in the Niagara Falls district and that imported from Canada. This information shows that practically all the power available is used to aid the prosecution of the war, direct war industries securing an average of 85.29 per cent of the total power of the two requisitioned companies and an average of 54.29 per cent of the total power of the coöperating companies. Under war conditions the power supply falls short of the demand by about 200,000 horsepower, which amount is not based on new industries but is determined as the amount of power which could be absorbed by the industries now operating, were such a supply available.

Some of this shortage will be relieved by the proposed enlargements of the steam plants of the Buffalo General Electric Co., and the Niagara, Lockport & Ontario Co. Additions to these two plants will aggregate 62,000 horsepower. By means of a further development by the American hydro-power companies at Niagara Falls their existing supply of power, amounting to about 250,000 horsepower, will be increased by about 160,000 horsepower. Many prominent men believe that the total available water power should be put to use.

The increased allotments of power to the essential electrochemical industries in the Niagara district and to the plants devoted to the production of such essentials as ferrosilicon, electrodes, phosphorus, chlorine and abrasives have conclusively demonstrated the beneficial results of regulating and controlling the distribution of power.

Governmental Control of Sulphur-Bearing Materials

THE War Industries Board has decided to take control of the production and allocation of sulphur, pyrites and coal brasses and has authorized Mr. William G. Woolfolk, commodity chief in charge of pyrites and sulphur, to act for the Board in controlling the production and distribution of sulphur materials.

It has been apparent for some time that the increasing consumption of sulphur-bearing materials would soon necessitate action looking toward the conservation of existing supplies and development of new sources. With this end in view the War Industries Board on May 29 requested the Chemical Alliance, Inc., to submit a plan covering the allocation of sulphur-bearing materials. The directors of the Alliance met on June 7 and decided to submit a plan. At the same time they invited the producers and consumers of sulphur-bearing materials to meet with them and approve or disapprove the plan. On June 11 the directors of the Chemical Alliance recommended the appointment of a committee to consist of three directors of the Alliance and a representative of the War Industries Board which should have charge of sulphur distribution. It appears that after receiving this report the War Industries Board decided to assume control for the Government. Mr. Woolfolk acting for the Board will avail himself of the assistance of the committee which the Alliance constituted at its meeting on June 7, which will probably comprise Messrs. A. D. Ledoux, W. D. Huntington and C. G. Wilson. Under the by-laws of the Alliance the president and vice-president act as *ex-officio* members of all committees. The committee will be known as the Committee on Production, Distribution, Control of Sulphur Materials.

Classification of Productive Occupations by War Department

In the regulations announced by Provost Marshal General Crowder affecting all men of draft age it will be of interest to chemists and metallurgists to note the following occupations which are indicated as productive:

Chemical engineer.	Digger (mucker),
Chemist or chemical worker:	Drill runner,
Acids and dyes,	Laborer,
Analytical,	Mine foreman,
Explosives,	Miner,
Fireworks,	Powderman,
General,	Quarry foreman,
Inorganic,	Quarryman,
Metallurgical,	Timberman,
Organic,	Topman,
Poisonous gases.	Track layer.
Foundryman:	Mining engineer.
Core maker,	Rubber worker:
Cupola tender (melter),	Bootmaker,
Furnace and ladleman,	General,
Molder.	Tire repairer,
Gas maker:	Vulcanizer.
Acetylene,	Sheet-metal worker:
Hydrogen, oxygen,	Coppersmith,
Illuminating gas,	Lead burner,
Poisonous gas,	Solderer,
Metal finisher:	Tinsmith,
Brass,	Any other.
Nickelplater,	Welder (cutter):
Niterbluer,	Aluminium welder,
Polisher.	Autogenous or oxy-
Millwright.	acetylene,
Miner or quarryman:	Electric,
Blaster,	Flue welder,
Crusher operator,	Thermit welder,
Demolition man,	Any other.

Price-Bidding in War Times

A Discussion of the Economic Principles Involved in Public Control of Industry Versus Unrestricted Competition—Effects of Price-Bidding on Labor and Production—Experience of Great Britain

By ROSWELL C. MCCREA

THE following quotations represent fairly well the prevailing economic philosophy of business men:

"The business of life is better performed when those who have an immediate interest in it are left to take their own course, uncontrolled either by the mandate of the law or by the meddling of any public functionary. The persons or some of the persons, who do the work, are likely to be better judges than the government of the means of attaining the particular end at which they aim . . . the individual agents have so much stronger and more direct an interest in the result, that the means are far more likely to be improved and perfected if left to their uncontrolled choice."

"*Laissez faire*, in short, should be the general practice; every departure from it, unless required by some great good, is a certain evil." (John Stuart Mill: *Political Economy*.)

"A market price . . . is a price fixed by the self-interest of buyers and sellers, each acting independently—that is, with *free competition* on both sides. The price thus fixed is generally an advantageous one for society. . . . If buyers are allowed to compete and force prices up at the very beginning of a scarcity, the advancing price at once operates as a warning to use the article economically. This of itself causes the article to hold out longer. It will also generally happen that the advancing prices lead the producers to send more goods to the market where higher prices prevail; and that long before the advent of actual famine new sources of supply are developed, by which the severest scarcity is avoided. If this result can be secured by a moderate advance in price, it is worth many times what it costs. For it must be remembered that high prices are not so much an evil in themselves, as an indication of an evil. If they exist in an open market, it shows that certain needs of the community are adequately supplied. It often happens that the higher prices serve as a natural cure for the underlying evil, and that the effort to force those prices down by custom or law prevents the evil from curing itself. If custom or law prevents buyers from paying a competitive price, it soon means that some buyers must go without things they very much want." (A. T. Hadley: *Economics*.)

This philosophy has recently come vigorously to the fore as a conclusive rejoinder to those who would safeguard public interests by regulating consumption, restricting competition and fixing price standards. Its basal assumption is that falling prices lead to reduced production. It has grown out of the observation of the proximate effects of price changes in a limited market, and takes little account of the causes and effects of changes in industrial technique or the underlying causes of productive efficiency. It posits a freely competitive organization, operating with mobile capital and labor units of constant efficiency, in which the profit incentive of rising prices stimulates the energies of producers already in the field and speedily draws into the competitive arena a host of new profit-seeking adventurers. The effect of this wholesome tendency is depicted as making for price-levels in which marginal costs are determinative and basal.

OBJECTIONS TO PRESENT ACCEPTANCE OF DOCTRINE

A fundamental objection to the acceptance of this point of view for present purposes is that freely competitive conditions do not exist and that production

units are neither freely mobile nor constant in efficiency. The psychology of those whose capital or whose energies are thrown into production is a variable quantity, the functioning of which varies in degree with industrial and social conditions. Price changes are merely one set of these conditions and their influence may easily be overestimated.

A dominant characteristic of modern industry is its large degree of use of capital goods in highly specialized, fixed forms. The old economist reasoned in terms of the corner grocery store with its easily fluctuating stocks of goods, which could be built up or depleted in a week. The typical modern establishment is the railroad or mine or factory. Its organization cannot be built up in a day. This requires months, often years, of planning and of preliminary production. Once established, its destiny is largely fixed. Its range of alternative uses is narrow. This condition has a marked influence on the flow of capital into new channels of utilization. The man of small capital or of undemonstrated capacity is ruled out by the size of the stake he must lay to get into the game, and the man of tried capacity and large command over resources will transform the wealth he may control into fixed forms only on the assurance of a reasonable profit margin and of a market of measurable permanency. A steady flow of profits is the lure, and certainty in price may be more of a stimulus to extensions and improvements than fortuitously rising prices.

FAVORED PRODUCERS PROFIT BY PRICE-BIDDING

As a fact, profits are quite as likely to result from lowered production costs, due to rising productive efficiency, as from rising price-levels. The latter may draw the productive margin to a lower level; but this may well be at the expense of possible output, if there is no accompanying improvement in methods of exploitation. The more advantageously situated production units will reap larger profits through an altered distributive alignment; but **no appreciable augmenting** of production is likely to result. Favored producers would be quite inclined by prevailing methods to make hay while the sun shines, while those on the margin who hesitate to make new fixed capital outlays would continue to hesitate. *Laissez faire* means hesitancy, and price-bidding means the swelling of the purses of more advantageously situated producers, without any corresponding increase of gross product. An established price, affording certainty for a reasonable period, would be much more likely to swell production. It would encourage the hesitant and by establishing a price norm would afford an incentive-laden standard by which to measure the effects of improvements in productive processes.

I have urged these considerations in hypothetical form. There are many historical, as well as contem-

poraneous illustrations of their truth. Permanent and substantial increases in the production of goods have come not from competitive price-bidding, but in consequence of the application of the fruits of experimental knowledge. Antecedent to every increase of production, changes in productive processes have occurred, and to these the augmented product should be credited. Increased production leads to falling prices. The former stands to the latter in the relation of cause and effect; rising prices and perennially growing production are not thus related. A seemingly paradoxical corollary of this thesis is that large fortunes have sprung from new products or new methods that have led to lowered prices rather than from increased prices accompanying stabilized production methods. The latter situation, where irremediable or unimprovable, has usually led to substitutions. We make a mistake in emphasizing fixed rather than variable conditions in economic reasoning. A current illustration is the food situation in Central Europe. Under the pressure of war, Germany did not trust to rising price-levels to assure her an

cheapness and plenty to the consumer. We can double the present agricultural output but only by methods which reduce its price."

HIGH PRICES VERSUS IMPROVED METHODS OF ORE TREATMENT

The same conclusion holds in the exploitation of underground resources. The uninitiated are apt to think of ore beds as of even composition, varying in thickness and in degree of advantage of location. Gradations of price are pictured, corresponding to the varying costs of exploitation of different beds. It is, of course, obvious that for the most part minerals are of uneven composition. At a given time the major portion of existing deposits may well be of too low grade to be worked at a profit. Rising prices make good mines more profitable, but do little to make the production of low-grade ores either abundant or profitable.

Low-grade ores come into use through new methods of extraction. The prodigious expansion of the steel industry has come, not because of increased prices of

TABLE I.

Commodity	Amount Produced 1911	Total Value	Amount Produced 1914	Total Value	Amount Produced 1916	Total Value	Amount Produced 1917	Total Value
Wheat (bu.).....	621,338,000	\$543,063,000	891,017,000	\$878,680,000	636,318,000	\$1,019,968,000	650,828,000	\$1,307,418,000
Corn (bu.).....	2,531,488,000	1,565,258,000	2,672,804,000	1,722,070,000	2,566,927,000	2,280,729,000	3,159,494,000	4,053,672,000
Oats (bu.).....	922,298,000	414,663,000	1,141,060,000	499,431,000	1,251,837,000	655,928,000	1,587,286,000	1,061,427,000
Rye (bu.).....	33,119,000	27,557,000	42,779,000	37,018,000	48,862,000	39,676,000	60,145,000	100,025,000
Barley (bu.).....	160,240,000	139,182,000	194,953,000	105,903,000	182,309,000	160,646,000	208,975,000	237,539,000
Potatoes, white (bu.).....	292,737,000	233,778,000	409,921,000	199,460,000	286,953,000	419,333,000	442,536,000	543,865,000
Rice (bu.).....	22,934,000	18,274,000	23,649,000	21,849,000	41,325,000	36,673,000	36,278,000	68,717,000
Sugar (short tons).....	960,374	102,664,000	968,674	91,500,940	1,133,626	156,009,600	1,094,240	167,703,220
Sheep and mutton (lb.).....	760,528,000	85,179,136	654,262,000	89,633,894	607,473,000	97,803,153	575,733,000	123,782,595
Cattle and beef (lb.).....	6,504,011,000	637,393,078	6,832,464,000	908,717,712	7,276,155,000	1,004,109,390	8,611,217,000	1,463,906,890
Hogs and pork (lb.).....	7,953,168,000	962,333,328	8,319,048,000	1,281,133,392	10,578,274,000	1,703,102,114	8,473,899,000	2,059,157,457
Bales of cotton.....	15,553,073	749,890,000	15,905,840	591,130,000	11,363,915	994,060,000	11,000,000	1,317,558,000
Raw wool.....	331,547,900	52,716,116	346,192,000	60,929,722	300,890,000	83,045,640	298,573,000	140,926,456
Iron ore.....	40,989,808	86,419,830	39,714,280	71,905,079	77,870,553	181,902,277	75,649,000	236,178,000
Copper ore.....	29,988,235	137,154,092	35,175,541	152,968,246	57,667,241	474,288,000	55,600,000	510,300,000
Pig iron.....	23,257,288	327,334,624	22,263,263	298,777,429	39,126,324	663,478,118	38,157,897	111,150,000
Steel rails (number).....	2,823,000	79,044,000	1,945,000	54,460,000	2,853,000	91,360,000	2,925,000	99,267,004
Locomotives built (number).....	2,915	52,002,939	1,485	25,788,078	2,380	57,202,146	3,076	206,100,974
Freight cars (number).....	64,810	39,708,199	95,253	92,123,511	118,016	132,559,842	123,558	25,072,294
Passenger train cars (number).....	3,499	42,837,111	3,623	45,245,589	1,338	17,001,885	1,621	3,599,971
Interurban and subway cars (number).....	557	3,417,574	304	1,660,117	552	2,113,520	426	3,984,502
Street railway cars (number).....	3,014	9,120,352	2,101	5,408,444	1,237	4,048,695	1,140	

adequate supply of grain. She turned to a cheaper substitute. But for the potato Germany would before this have been starved into submission. Many of the productive potato lands were barren soil a century ago. Scientific experimentation adapted the potato to these waste regions, supplemented by soil analysis which afforded knowledge of added elements requisite for potato cultivation. Beyond the limits of any possible increase of production through the bidding up of prices, is an immeasurably larger permanent increase of gross product resulting from better application of skill and knowledge to local conditions.

HIGH PRICES FAIL TO STIMULATE PRODUCTION

"The production of sheep and wool in England was stationary until improvements in food and in breeding were wrought. It was the turnip and the new breeds of sheep which increased production of wool and not its high market price. The changes in cattle breeding both in regard to milk and beef tell the same story. The growth of these industries is a history of improved methods, each great change in the quantity produced being the consequence of antecedent stock improvements. These lessons America must take to heart if a remedy for our food shortage is to be found. High prices of food products will fail to stimulate an increase of their production. The remedy is in improved methods of production bringing prosperity to the farmer but also

pig iron, but through new processes of extracting ores and new economies of manufacture. The increase in the production of silver is a good example of the same tendency. The output of silver remained stable for centuries, little affected by prevailing high prices. What high prices could not do was accomplished by advancing chemical art. Increased production at lower prices followed.

"The history of every mineral product tells the same story. Stationary production is the accompaniment of high prices. We get increased production not in this way but by discovery, invention and increased knowledge, making the growth a result of these causes and not of price bidding. High prices is a distributive process creating profits, not a productive process augmenting production. Only when this is seen can an epoch of high prices like the present be understood. The urgency of war leads to vain attempts to speed up production. From them come high prices and inflation, but gross production is more often decreased than increased thereby."

A current experience of some illustrative value in this connection is brought out by figures published in the annual report to stockholders of the United States

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Steel Corporation for 1917. There is a falling off in tonnage of approximately 5 per cent.

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The lack of correspondence between rising market values and volume of product is well illustrated by Table I. In the case of agricultural products, fortuitous and incalculable elements, such as varying weather conditions, have had an important effect. But the figures still have appreciable value.

THE ENDLESS CHAIN IN PRICE-BIDDING

A significant cause of the failure of price-bidding inflation to yield corresponding expansion in gross product lies in the fact that the bidding up tendency speedily extends to labor and intermediate goods which are in turn the products of labor. The wished-for harvest is great; and laborers are few. Immigration has virtually ceased. Our labor supply has become a fixed quantity and as successive military drafts make necessary inroads, the labor force will doubtless show an absolute decrease. Under these conditions, unrestricted price-bidding for essential commodities will merely raise market prices. These will be reflected in turn in expanded wage costs and inflated prices for machinery and related equipment, which are in turn labor products. The outcome is an alteration in distributive or income results without even approximate ratio of increase in volume of product. Profits mount amazingly in war-stimulated industries; labor moves toward such industries at rapidly advancing wage rates; non-transformable industries, not essential to the purposes of war, decline in material and financial productiveness. Price-bidding has caused a shifting of activities, an increase in market values; but aggregate product has diminished. The lure of advancing profits resulting from the raising of price margins yields no generally desirable social results. Profit is not product, and profit can serve as an incentive to product only when enlarged or better organized or more efficient labor force can be applied to tasks in hand. During the past year there has been no enlargement on better organization or demonstrable increase in the efficiency of labor. A reverse experience is the regrettable fact.

There has been no lack of price-bidding for the services of labor. With war industries setting the pace, wage rates have shown unprecedented advance. The following rates per hour are illustrative of minimum wage standards now prevailing in shipyards. These rates are for an eight-hour day, with time and a half for over-time, and double time for Sundays and holidays:

	Rate per Hour
Angelsmiths.....	\$0.87½
Hammer and machine forgers, heavy.....	1.35
Bolt makers.....	.72½
Electric welders.....	.65
Boiler makers.....	.70
Erecting leaders.....	.85
Drillers.....	.55
Chippers and calkers.....	.70
Painters and polishers.....	.60
Laborers and helpers, from.....	.40 to .46

Changes in wage distribution between 1915 and 1917 strikingly emphasize the upward trend of wages.

Massachusetts figures, drawn from returns made by workers in whose cases compensation for industrial injuries was awarded, are quite illustrative:

Weekly Wage Group	1915 Per Cent	1916 Per Cent	1917 Per Cent
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20.01-25.....	6.30	9.26	18.35
Over \$25.....	2.66	3.52	15.18
Average wage.....	13.13	14.53	18.39

It will be noted from these figures that in 1915 only 2.66 per cent of the workers received a wage in excess of \$25 per week; in 1916, 3.52 per cent; in 1917, 15.18 per cent. At the same time, the percentage of those earning less than \$10 per week declined from 26.41 in 1915 to 7.92 in 1917.

The effect on wages of the expansion of munitions manufacture is well indicated by the following figures of a well-known New Jersey plant.

Weekly Earnings	Male Workers Over 16 Years of Age Per Cent of Total			
Under \$15.....	1916	1917	1916	1917
\$15 but under \$20.....	812	89	36.4	2.5
\$20 and over.....	815	450	36.5	12.6
Total.....	605	3,023	27.1	84.9
	2,232	3,562	100.0	100.0
	Female Workers Over 16 Years of Age			
Under \$12.....	1,412	1,245	100.0	45.8
\$12 and over.....		1,477		54.2
Total.....	1,412	2,722	100.0	100.0

It will be noted that in the case of male workers only 27.1 per cent earned \$20 or more per week in 1916. In 1917, 84.9 per cent earned \$20 or more. In the case of the female workers, none earned as much as \$12 per week in 1916. In 1917, 54.2 per cent were earning \$12 or more.

LABOR DEMORALIZED BY PRICE-BIDDING

No one endowed with adequate fellow-feeling would suggest that workers are not justified in making their demands as urgent as possible and in gaining every advantage from the present labor shortage that may honestly be turned to account. They have at least as fitting a claim as have other classes which are profiting by the war. Their necessities are greater, and their real gains in the goods that money will buy will in any case not be appreciable. There is a vast difference, however, between a justification of their effort to alter the distribution of income and the maintenance of a view that increased wages will enlarge industrial output. The Director General of Railways is about to put into force wage increases for railway workers which will aggregate several hundred million dollars. Will the workers' contribution to transport services show any corresponding augmentation? The answer is reflected in the increase of freight and transportation charges already in process of application. There will be no change in output of railway services attributable to wage increases. The same is true of the wage-bidding of munition and ship-building plants. Labor has been demoralized. Workers have become bargain hunters. Labor turnover has assumed unwanted proportions. A round of visits to ship-building plants made nine weeks ago showed many groups of workers vigorously discussing wage-rates and earnings, rather than bolting ship-plates or driving rivets. Superintendents and bosses were exercised and often incensed, but helpless. Governmentally standardized wage-rates have since afforded a measure of improvement, and

poraneous illustrations of their truth. Permanent and substantial increases in the production of goods have come not from competitive price-bidding, but in consequence of the application of the fruits of experimental knowledge. Antecedent to every increase of production, changes in productive processes have occurred, and to these the augmented product should be credited. Increased production leads to falling prices. The former stands to the latter in the relation of cause and effect; rising prices and perennially growing production are not thus related. A seemingly paradoxical corollary of this thesis is that large fortunes have sprung from new products or new methods that have led to lowered prices rather than from increased prices accompanying stabilized production methods. The latter situation, where irremediable or unimprovable, has usually led to substitutions. We make a mistake in emphasizing fixed rather than variable conditions in economic reasoning. A current illustration is the food situation in Central Europe. Under the pressure of war, Germany did not trust to rising price-levels to assure her an

cheapness and plenty to the consumer. We can double the present agricultural output but only by methods which reduce its price."

HIGH PRICES VERSUS IMPROVED METHODS OF ORE TREATMENT

The same conclusion holds in the exploitation of underground resources. The uninitiated are apt to think of ore beds as of even composition, varying in thickness and in degree of advantage of location. Gradations of price are pictured, corresponding to the varying costs of exploitation of different beds. It is, of course, obvious that for the most part minerals are of uneven composition. At a given time the major portion of existing deposits may well be of too low grade to be worked at a profit. Rising prices make good mines more profitable, but do little to make the production of low-grade ores either abundant or profitable.

Low-grade ores come into use through new methods of extraction. The prodigious expansion of the steel industry has come, not because of increased prices of

TABLE I.

Commodity	Amount Produced 1911	Total Value	Amount Produced 1914	Total Value	Amount Produced 1916	Total Value	Amount Produced 1917	Total Value
Wheat (bu.).....	621,338,000	\$543,063,000	891,017,000	\$878,680,000	636,318,000	\$1,019,968,000	650,828,000	\$1,307,418,000
Corn (bu.).....	2,531,488,000	1,565,258,000	2,672,804,000	1,722,070,000	2,566,927,000	2,280,729,000	3,159,494,000	4,053,672,000
Oats (bu.).....	922,298,000	414,663,000	1,141,060,000	499,431,000	1,251,837,000	655,928,000	1,587,286,000	1,061,427,000
Rye (bu.).....	33,119,000	27,557,000	42,779,000	37,018,000	48,862,000	59,676,000	60,145,000	100,025,000
Barley (bu.).....	160,240,000	139,182,000	194,953,000	105,903,000	182,309,000	160,646,000	208,975,000	237,539,000
Potatoes, white (bu.).....	292,737,000	233,778,000	409,921,000	199,460,000	286,953,000	419,333,000	442,536,000	543,865,000
Rice (bu.).....	22,934,000	18,274,000	23,649,000	21,849,000	41,325,000	36,673,000	36,278,000	68,717,000
Sugar (short tons).....	960,374	102,664,000	968,674	91,500,940	1,133,626	156,009,600	1,094,240	167,703,220
Sheep and mutton (lb.).....	760,528,000	85,179,136	654,262,000	89,633,894	607,473,000	97,803,153	575,733,000	123,782,595
Cattle and beef (lb.).....	6,504,011,000	637,393,078	6,832,464,000	908,717,712	7,276,155,000	1,004,109,390	8,611,217,000	1,463,906,890
Hogs and pork (lb.).....	7,953,168,000	962,333,328	8,319,048,000	1,281,133,392	10,578,274,000	1,703,102,114	8,473,899,000	2,059,157,457
Bales of cotton.....	15,553,073	749,890,000	15,905,840	591,130,000	11,363,915	994,060,000	11,000,000	1,517,558,000
Raw wool.....	331,547,900	52,716,116	346,192,000	60,929,722	300,890,000	83,045,640	298,573,000	140,926,456
Iron ore.....	40,989,808	86,419,830	39,714,280	71,905,079	77,870,553	181,902,277	75,649,000	236,178,000
Copper ore.....	29,988,235	137,154,092	35,175,541	152,968,246	57,667,241	474,288,000	55,600,000	510,300,000
Pig iron.....	23,257,288	327,334,624	22,263,263	298,777,429	39,126,324	663,478,118	38,157,897	1,111,500,000
Steel rails (number).....	2,823,000	79,044,000	1,945,000	54,460,000	2,855,000	91,360,000	2,925,000	99,267,004
Locomotives built (number).....	2,915	52,002,939	1,485	23,788,078	2,380	57,202,146	3,076	206,100,974
Freight cars (number).....	64,810	59,708,199	95,253	92,123,511	118,016	132,559,842	123,538	25,072,294
Passenger train cars (number).....	3,499	42,837,111	3,623	43,245,589	1,338	17,001,885	1,621	3,599,971
Interurban and subway cars (number).....	557	3,417,574	304	1,660,117	552	2,113,520	426	3,984,502
Street railway cars (number).....	3,014	9,120,352	2,101	5,408,444	1,237	4,048,695	1,140	

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more rigorous control over the distribution and migration of workers will sooner or later do much more; but what has been done cannot be undone.

"It is the conditions which surround the worker that determine his efficiency. Improvements in health, sanitation, housing and other elements in the home environment have a bearing on industrial efficiency and by them are the betterments of the worker to be measured. Price-bidding thwarts what the local environment stimulates. It leads to dissatisfaction, dissipation and to misplaced energy. Its lesson is therefore the same as that of other price bidding whether in food products or in raw material. There is an increase of waste but not of product. Increased production comes from an organization of the hitherto unused or partially used elements of the working population. It is easier to raise lower groups to a higher efficiency than to divert well-paid workers from one occupation to another. A new industry in war time or in peace should build up its own laborforce out of the misplaced or partially used workers. A worker's training can be readily acquired if the discipline and oversight is what it should be. The increase of production mainly depends on moving those below the normal standard of living up to this standard and not on giving more to those above this standard.

"Why the moving of workers up to a decent standard of living is a productive problem is clearly shown by the rejection of recruits in the recent draft. Above 35 per cent of the recruits were rejected, of which 60 per cent were for removable causes. It is also estimated on the basis of these facts that three-fifths of those between 31 and 45 are physically unfit for military duty. A half of the working population are thus below the normal level of physical vigor and of these, more than a half are disabled from preventable causes. When we realize the reduction in labor efficiency which these defects cause, we can readily see what their removal means. Industry would gain both in gross and net product if the cost of removal were assessed against it. This shows what a living wage with proper care of health, sanitation and housing would do. The interest of every portion of society is promoted thereby. The sacrifices of the poor aid no one. They reduce both the gross and net return of industry.

HOW REALLY TO BENEFIT LABOR

"The way to benefit the higher class of laborers is not by higher wages but by increased inducement to save. Price bidding makes spenders and increases both extravagance and waste. Saving aids production and modifies workers in ways which increase production. The man who spends all he earns, be he a worker or a salaried man, is dependent on a capitalist class, and to increase production will in the long run be the victim of the social order his defects make necessary. It is higher rates of interest which the uplift of the worker demands. He needs motives to check spending and not a freedom to indulge his caprice."

Much can also be done by the working out of a comprehensive policy of labor distribution through a coordinated system of labor exchanges. The present indiscriminate practice of drawing workers from their present attachments by peripatetic employment agents and by promiscuous advertising cannot be too strongly

condemned. A centralized system of registration with local agencies to estimate local needs and to facilitate the distribution of workers would afford a vast improvement over prevailing anarchical conditions. A sample of what might be done in this direction has been afforded by English experience and by recent experimentation in the State of Ohio.⁴

A marked shortcoming of the competitive price-regulating régime, often unrecognized, is the wasteful duplication and lack of unity in the use of large-scale facilities of production and marketing. It is a well-recognized fact that large-scale producing units, involving the use of highly specialized and highly expensive equipment, tend to become cut-throat in their competitive practices. Some sort of common arrangement with regard to marketing practices is an inevitable outcome. But, short of actual combination, these arrangements, though financially salutary, have contributed little to the attaining of operating unity, so essential to the elimination of waste. Pools have been effective as dividend savers, but useless in directly promoting growth of product and of services from coordinated management. Railroad history affords striking illustrations of this situation. Railroad pools were never formed for any other purpose than control over rates. The carriers discovered through sad experience that competitive rate-warfare was disastrous to strong and weak roads alike. The pool was a resulting device to prevent rate-cutting by apportionment of competitive traffic or of the receipts from such traffic among the roads concerned. Pools were declared illegal by the courts, but subsequently established understandings have been no less effective. It is no fortuitous circumstance that rates between competitive points are the same on rival roads with equal facilities, nor is it mere chance that rate increases are simultaneously announced by rival lines. Strictly viewed, these agreements may have been illegal; but they have been winked at because public authority has had power to prevent arbitrary increases.

WASTE THROUGH LACK OF UNITY

But the mere existence of pools and agreements operating under public sanction did not produce operating unity. To the contrary, examples of uncoordinated organization and operation are legion. In the New York district there is an extreme example of wastefully competitive terminal facilities, where topographical conditions would permit high operating efficiency. Engineering experts have pointed out again and again how certain belt and marginal railroads with bridges or tunnels would bring the terminal facilities of the harbor into a great flexible unit. But the monopoly of a single road has forced continued reliance on scattered, inadequate and wasteful arrangements.

Some years ago the Wabash Railroad began to build a subsidiary line into Pittsburgh. The money spent by the Wabash in furthering its plans added to that spent by the Pennsylvania in opposing them would have paid for the construction of an adequate Pittsburgh terminal. Of what inestimable value such a terminal would have been during the past two years of traffic congestion in Pittsburgh!

⁴Cf. of two articles by W. M. Leiserson in *The Survey* for March 30 and April 20, 1918. Also Lescohier: "A Clearing-House for Labor," *Atlantic Monthly*, June, 1918.

³Patten, *supra* cit.

In Chicago twenty-five trunk lines enter the city. These have twice the trackage requisite for the handling of freight under a unified terminal system. Every day some 2000 tons of through freight, in less than car-load lots, are hauled by truck from inbound to outbound stations. In fact, almost the whole of Chicago's terminal system is obsolete and needlessly inefficient. Admirable plans of reorganizations have been worked out; but these have been fruitless because individual companies will not surrender strategical advantages acquired in the early days of their development. One cannot blame the managers of the roads. They have but followed the competitive creed under which our railroads have developed. Within the past year, under the stress of war, there were efforts at coördination, but these could not be made completely effective under private management. The Government has taken over the roads, in all likelihood for a period of years. As President Wilson has said: "The group of railway executives who are charged with the task of actual coördination and general direction performed their difficult tasks with patriotic zeal and marked ability, as was to have been expected, and did, I believe, everything it was possible for them to do in the circumstances. If I have taken the task out of their hands, it has not been because of any dereliction of failure on their part, but only because there were some things which the Government can do and private management cannot."

What is true of the railroads in war times is measurably true of other complicated, large-scale, competitive units in other fields of production and distribution.

The considerations thus far urged have received more or less conscious recognition in the practices and policies of the nations at war. Aside from our own, we know most about the British experience.*

WAR-TIME EXPERIENCE OF GREAT BRITAIN

Starting with a strong predilection for *laissez faire*, British control of industry has passed through three phases. The first, extending over a period of less than a year, was one of tentative action, looking only toward obvious measures of self-protection. The second, lasting for some seventeen or eighteen months, was a period of determined regulation. The Government's chief concern was that of increasing the output of munitions of war, of securing supplies for the army at prices below those of the market, and of regulating shipping. The third phase, beginning at the end of 1916, has been one of stringent control, governmental regulation of the production, distribution and consumption of food being its most prominent feature. "The doctrine of *laissez faire*, still respected in 1914, had by the end of 1917 passed into at least temporary oblivion."

Control over the prices and distribution of essential metals are typical of British practices. Through the medium of this control, the Ministry of Munitions achieved triumphant results during the first year of its activity." This involved interferences with the

normal course of trade which went beyond even the control of employers' profits and the restriction of trade unions' liberties and practices. Raw materials were controlled throughout the processes of conversion into munitions. "The great lesson of the early months of the War," said Mr. Montagu in an August, 1916, speech before Parliament, "was that munitions cannot be obtained merely by ordering. You have got to see that the man who takes your orders has the plant and the labor; you have got to follow up the work process by process; you have got to provide from the beginning to the end everything that is necessary. That is the cardinal principle of the Munitions Department."

Following this principle, the Government early turned its attention to the supplies and prices of iron, steel and copper. During 1915 market quotations for these metals had advanced rapidly. Conditions in the import trade were largely responsible. American supplies had been so largely diverted by home demand that semi-steel could scarcely be obtained. Freight rates, too, rose from 15s. to 65s. per ton. As a result, the price of bar-steel, used in shell making, advanced from £7 15s. in January, 1915, to £11 in July, and to £14 in December. American billets, which early in the war brought £5 per ton c.i.f., so far as available at the end of the year, sold for £10 10s. Hematite rose from 71s. a ton in January to 115s. in December. The increased value of skilled labor needed to transform forge pig into bar pig was reflected in a changed price ratio of from 1 to 2, to 1 to 3/1.

GOVERNMENT FIXES MAXIMUM PRICES

This was the status of price movements in January, 1916, when the Government resolved to prevent further appreciable rise in prices. Maximum prices for all finished iron and steel goods were fixed. These were revised in April and again in November. The following quotations will illustrate the stabilizing effect of these measures:

	January, 1915	January, 1916	December, 1916
Steel ship plates, per ton.....	£8	£11 10s	£11 10s
Iron ship plates.....	£7 15s	£11	£11 10s
Steel sheets (singles).....	£8 5s	£13 10s	£14
Common iron bars.....	£8	£10 10s	£10 15s
Heavy steel rails.....	£6 7s 6d	£11	£10 17s 6d

At the end of February maximum rates were set for pig-iron below those ruling in the market. On Feb. 22, Cleveland No. 3 sold in Glasgow for 98s. 6d.; on the following day there were rumors that the Government would insist on transactions at 82s. 6d. The market broke forthwith, and 2500 tons were sold at 87s. 6d. Private transactions continued for some weeks, but gradually waned until the metal exchanges in London and Glasgow lapsed into lifelessness.

The Government next took steps to stabilize the price of iron ore, of which in 1916 some 6½ million tons were imported. But guarantees were given, both in freight rates and in ore prices, to meet any differences that might arise between fixed prices and actual costs. Precautionary notice was served that the maximum prices for steel and iron were based upon abnormal costs and conditions then prevailing, and must not be assumed to indicate differences in relative values obtaining in the several districts before the war, or which might obtain again after the war.

*My illustrations of railway conditions have been drawn from one of a series of five striking articles, by T. W. Van Metre, now running in *The Traffic World*. The article in the number for May 11, 1918, affords a significant discussion of the faults of private management.

*An excellent discussion of the British experience will be found in Gray, H. L., "War-Time Control of Industry," The Macmillan Co., 1918.

*Gray, *supra* cit.

*My facts are drawn from Gray, *supra* cit.

On Feb. 29, 1916, the Government forbade speculative trading. Thereafter, dealings in iron, steel, copper, zinc and certain other metals became unlawful except in cases of direct transfer by owner to consumer or consumer's agent. During January and February the prices of copper, lead and iron, owing largely to speculative dealings, had reached previously unprecedented war levels. Copper was higher than since 1907, and the other metals had broken previous records. Compared with 1913, the quotations were:

	Highest Price Since the War	Highest Price in 1913	Lowest Price in 1913
Copper per ton.....	£108	£78	£62
Lead.....	£35	£22	£15
Spelter.....	£120	£27	£20
Iron.....	98s.	70s. 6d.	48s. 6d.

Under the new prescriptions iron was to be sold at 82s. 6d. Copper was imported, so that its price could not be fixed. There have since been marked fluctuations in copper prices; but, at least, profits of home speculators were eliminated.

ECONOMY AND EFFICIENCY IN THE USE OF MATERIALS

The next step was that of securing economy and efficiency in the use of metals. Restrictions were first put upon the exportation of iron and steel to neutrals. As early as July, 1915, the exportation of high-speed steel had been prohibited, except under license; and thenceforth only a small part of the licenses asked for were granted. Early in 1916 neutral markets were further closed, except through occasional grant of permits to adjust the balance of trade. Of this the shipment of steel rails to South America is an example.

As between home consumers, priority regulations ruled. In the beginning they affected only controlled establishments; but by March, 1917, more than 90,000 firms had been brought within their scope. With an underlying purpose of securing essential supplies to industries in the order of war-time importance, they provided, relative to steel and copper wire, that no order (other than for shell-discard quality) should be accepted by a manufacturer except with Government approval. Such approval was safeguarded by detailed regulations; and each week manufacturers were required to make full returns to the Director of Steel Production of all steel manufactured or delivered.

PRIORITY PRINCIPLE APPLIED TO LABOR

The principle of priority in industrial work was next extended to contracts for the employment of labor under a Restricted Occupations Order. Industries not conducive to military ends were by these means forced to the wall.

"By the spring of 1917 the Government was in pretty complete control of the vast business of manufacturing munitions, especially in control of the supply of iron and steel. Its first endeavor had been to enlist in its service private engineering and shipbuilding firms and to attempt the mobilization of labor; it had ended by fixing the price of iron and steel by determining the allotment of these and other metals to the manufacturer and by directing the supply of labor into essential trades. It had, in short, extended its control from producer to consumer, undertaking almost everything except the appropriation of the mines and the works."

Judged by any standard of the adapting of means to

ends, British experimentation has been a success. Employers have complained little except in non-essential trades. Some would have welcomed a more liberal export policy in order to share in the higher prices of the world market. But essential industries have been crowded with orders, and business has been continuously active. A liberal profit margin has prevailed, so that little friction has developed between manufacturers and the Government. And most of all, ships, munitions and other war essentials have been turned out in growing volume.

PRICE-FIXING GOOD ECONOMY

Great Britain has been impelled further toward state control of industry than the United States has thus far gone. We are still much more largely reliant than they on the voluntary coöperation of citizens. Only time can tell how far we shall go in their direction. But in any case, governmental judgment is quite likely to coincide with that recently expressed in the columns of a popular weekly:

"Of course price fixing curtails production. With more pinches there will probably be more criticism of it on that ground. When coal prices were soaring, without a check in sight, mines that could not be worked profitably at anything like normal prices were opened up. Almost any sort of contrivance in which iron could be made found a profit in operating when that commodity sold round seventy dollars a ton. When the Government fixed the price at thirty-three dollars resurrected and improvised furnaces had to shut down.

"But price-fixing, though it does cut out a certain amount of extravagantly dear production, is good economy. The country is in a sounder position with somewhat less iron at thirty-three dollars a ton than it would have been with a somewhat greater output at seventy dollars. The increased supply of either coal or iron would have been relatively small. In the case of coal the real famine was in transportation rather than in fuel." An increased supply at the mines would have done no good when cars were not available to haul it. The iron pinch is quite as much a lack of transportation and labor as of metal. The stock of materials will answer if it is handled to good advantage.

"The objections to abnormal prices are psychological and political as well as economic. Few things in this sordid world are more likely to put a nation out of tune than having to pay double or treble the accustomed price for a necessary article of universal use. At best, high prices are bound to be a sufficient affliction during the war. Limiting the price of certain basic articles by Government action would be justified as a political measure, even if it could be shown, by some miraculously comprehensive calculation, that there was no net economic gain in it."

Columbia University.
New York City.

Exports of gold for April 1918 were 3560 thousand dollars with imports exceeding 2745 thousand dollars, leaving a balance of gold movement against us in excess of 814 thousand dollars.

¹⁰Saturday Evening Post, June 1, 1918.

¹¹See tabulation on p. 72. Compare output of locomotives and cars with that of the various raw products.

¹²Gray, *supra* cit. p. 47.

Flotation Apparatus, Their Design and Operation

Classification and Summary of the Types of Machines—Capacity, Air and Power Consumption—Cost of Equipment

By A. W. FAHRENWALD

IN THE last three years great strides have been made in mechanical appliances for the purpose of concentrating ores by the flotation process. Many patents have been taken out for such devices, and a large number of them have been put into operating mills and are giving satisfactory results; others have not reached such wide application.

Before proceeding to a discussion of the various types of apparatus used in the process, it will be necessary to classify them. The classification which will follow does not include types that have served as a link in the chain of designs leading to the present developed system. Neither will it include the so-called "film" flotation processes, as their field of usefulness seems to be quite limited, and since most of these processes or methods are expensive because of the limited amount of mineral that can be floated at one time on the surface film of water. They can not handle finely divided slime, yet it is certain that the present popularity of "froth flotation" depends on its success in the treatment of ore-slime. For this reason it is easily seen that the application of machines using the "skin" or "film" principle is limited. It is noteworthy, however, that McQuisten's method is at present in use for the treatment of table middlings at the Morning Mill, at Mullen, Idaho. Barite and siderite are there present as gangue minerals in a middling containing zinc and lead sulphides. As these heavy gangue minerals can not be separated by gravity methods of concentration, the alternative of grinding them fine enough for froth flotation or of treating them by film flotation has so far enabled the latter to survive the competition of froth flotation. At the ore-testing plant of H. E. Wood, of Denver, a film flotation machine is also removing molybdenite from a low-grade ore. There is little doubt, however, that froth flotation could be used for every separation of minerals that is now being accomplished by film flotation, providing the material were ground fine enough.

The following classification, then, includes apparatus most widely used in practice:

- I. Straight mechanical frothing machines.
 1. "Minerals Separation" type of machine.
 2. Janney machine.
- II. Mechanical-air frothing machines.
 1. Minerals Separation sub-aëration machine.
 2. Janney mechanical-air machine.
 3. Kollberg-Kraut (K. & K.) machine.
- III. Pneumatic frothing machines.
 1. The Callow pneumatic machine.
 2. Flinn-Towne machine.
 3. Cole-Bergman machine.
 4. Inspiration machine.

5. Launder machine (Snyder).

IV. Gravity frothing machines.

1. So-called "cascade" or "hydraulic" flotation machines.

The above classification is based on the fact that all machines recover the mineral sought by forming a froth or foam. Without the formation of a froth, the physics of which has been discussed frequently in the technical press,² no mineral will be concentrated. In the important froth flotation processes the mineral-carrying froth is produced by either beating air into the pulp by mechanical means or by injecting it in the form of small bubbles.

I. STRAIGHT MECHANICAL FROTHING MACHINES

Machines of this class probably were the first to receive practical application. They advanced regularly

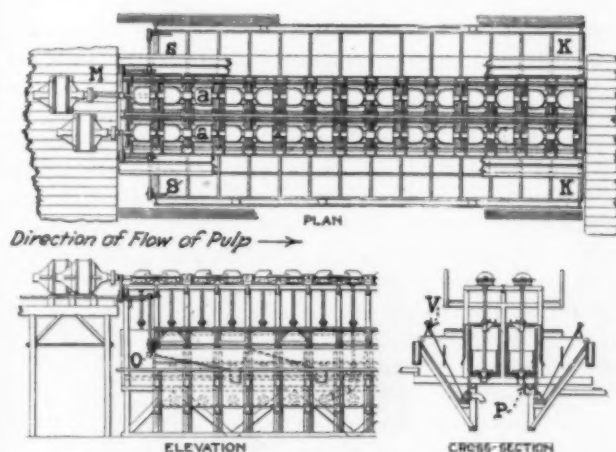


FIG. 1.—THE MINERALS SEPARATION MACHINE

in design, reaching a fairly high state of perfection before the pneumatic type was introduced.

1. The "Minerals Separation" type owes its present state of development and perfection to the metallurgical staff of Minerals Separation, Ltd., among whom Froment, Cattermole, Picard, Sulman, Ballot, Nutter and Hoover deserve special mention. The ideas of many others have also been taken over by this company.

The Minerals Separation machine used at the present time will be described best by reference to the installation at the Washoe Reduction Works of the Anaconda Copper Company.³ Fig. 1 shows the machine at various angles.

The feed is introduced into the first agitation box at the motor end of the machine, M. From this box

²"On the Molecular Physics of Ore Flotation," Coghill and Wright. This Journal, June 1, 1918.

³"Flotation Concentration at Anaconda," Bull. A. I. M. E., March, 1916.

⁴See "Flotation in the Coeur d'Alenes," C. T. Rice, *Engineering and Mining Journal*, Vol. 105, p. 709 (Apr. 20, 1918).

it passes to a second box through an opening O in the partition, as shown in the elevation. From this second agitation compartment the pulp passes into the first spitzkasten S, where the first concentrate froth is formed and removed by means of a paddle. The pulp remaining passes through a pipe P, the inlet to which is controlled by a valve stem V, to the third agitating box A. From this agitating box the pulp

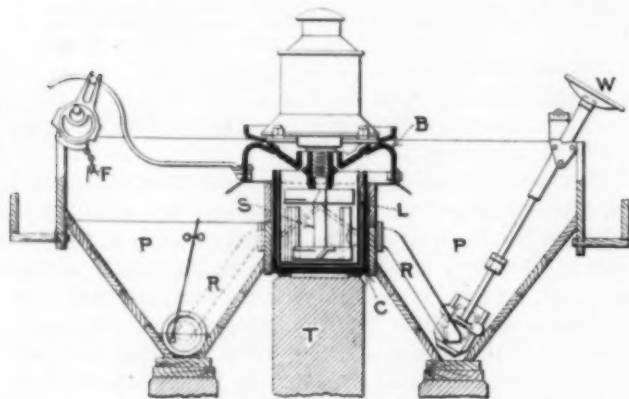


FIG. 2.—JANNEY MECHANICAL FLOTATION MACHINE

passes through the second spitzkasten, and so on through the machine until the pulp is introduced into a fourteenth or last spitzkasten K. The discharge from the last spitzkasten leaves the machine as tailings. The first four to seven spitzkasten make finished concentrates and the remaining ones make middlings that are returned to the system. The drawings show a double machine—each machine however, being run as a separate unit. The line shaft is driven by a 150-hp. motor at a speed of 385 r.p.m. and requires about 100 hp. under load. The vertical shafts carrying the impellers revolve at a speed of 225 r.p.m. The impellers have four blades placed at right angles and inclined 45° to the vertical, made of gun metal, 18 in. in diameter, giving a peripheral speed of 1,060 feet per minute. Each pair of impellers is so arranged that they revolve in opposite directions, which tends to balance the side thrust on the line shaft. The bevel gears that drive the impeller shaft are cut-steel and run in grease. The impeller shaft is supported both vertically and horizontally by ball bearings.

The machines are made of California redwood; the agitator boxes are further lined with hard maple extending about 18 in. from the bottom of the box.

Each machine makes three products: concentrate, which goes to the dewatering division; middling, returned to the head of the machine; and tailing, to waste. Concentrate is taken from the first three to five spitzkasten and middling from the last nine to eleven.

2. Janney Machine. Fig. 2 shows the mechanical machine,⁴ which is constructed of cast iron, with the exception of the spitzkasten. The whole machine is

attached to a main casting C which sets on a foundation of concrete or timber T in the middle (Fig. 2). Inside this main casting is a liner casting L which takes the wear, and which is baffled on the lower portion so that the pulp receives a very violent agitation. Above the main casting sets a top liner B and a support for the motor. A shaft S, on which there are two impellers, is screwed to the lower end of the motor shaft, and turns with the rotor at a speed of about 570 r.p.m. It is made heavy enough, and the bearings in the motor are of sufficient size, so that there is but little vibration. The impellers on these shafts are of two sizes; the lower one is the smaller and revolves inside the baffle on the liner, while the upper one revolves just above the baffles, and throws the pulp up and out into the spitzkasten P on either side of the agitating chamber.

The Janney machines are of the double spitzkasten type, i.e., each agitator serves two spitzkasten. On each side of the agitating chamber there are two open-ended circulating pipes R, which lead from the bottom of the spitzkasten up and into the same agitating chamber. Each spitzkasten is divided by a baffle or partition, which prevents the pulp from flowing through the series of machines without passing through the agitating chambers. Any desired height of pulp-level is maintained by regulating a gate between the spitzkasten with a hand wheel W, then the rate of flow from "spitz to spitz" depends entirely upon the volume of feed entering the machine. The amount of pulp circulating in each unit machine builds up to its capacity, and then remains constant, due to the regulating gate between the spitzkasten.

The circulating feature of the machine allows the pulp to be treated many times. When the pulp is thrown out from the agitating compartment into the

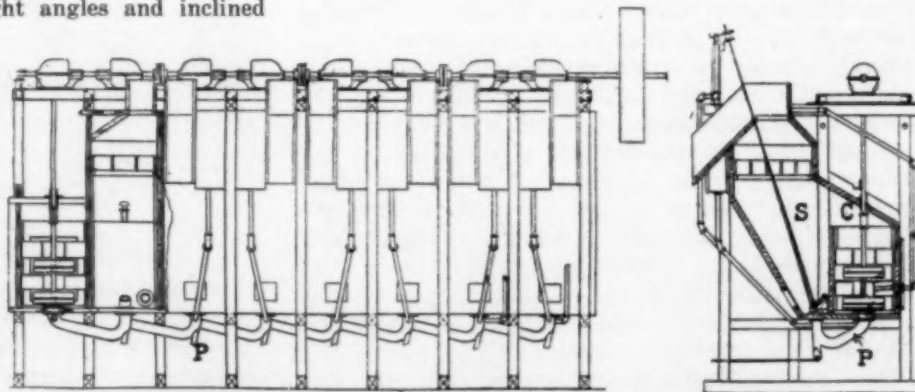


FIG. 3.—MINERALS SEPARATION SUB-AERATION TYPE OF FLOTATION MACHINE

spitzkasten a froth is produced. A froth remover F driven by a small motor installed at one end of the row of machines removes it as formed.

A typical installation of Janney mechanical frothing machines (known as a multiple-series arrangement), consists of two mixers or "emulsifiers" and fifteen Janney mechanical machines in a row. In such an installation the feed is divided among the first five cells. The tailing of each of these five cells enters the sixth cell and from the sixth cell it advances from "spitz to spitz." The slope required is $1\frac{1}{2}$ inches per foot.

This machine is adapted to the treatment of a classified feed or of ores of high mineral content, and is

⁴Catalog, Stimpson Equipment Co., Salt Lake City, Utah.

especially adapted for treatment of low-grade concentrate produced on tables or vanners. The feed should all pass 40-mesh for best results, while the percentage of solids in the feed should range from 20 to 23 per cent.

A feature of this machine distinct from most other mechanical agitation machines lies in the individual motor drive for each agitator compartment. This arrangement is accompanied by the many advantages accruing to any individual-motor-driven machine, but its high first cost would usually be beyond the means of the small operator.

II. MECHANICAL-AIR FROTHING MACHINES

In most cases these machines have been introduced since the debut of the pneumatic system of floating minerals. The object in this machine is to combine the advantages of both injected air and mechanical agitation. This combination increases the chance that any particle will be caught in traveling a given distance.

1. The Minerals Separation Sub-aeration Machine.

As seen from the illustration,⁵ Fig. 3, pressure air is admitted to the pulp conduits P leading from the spitzkasten to the agitation compartment next in succession, in order to make this air available in lifting mineral to the top of the spitzkasten where it can be skimmed off. The agitating compartments are closed at the top by covers C set on an incline in such a way that the air rising to the top in the agitating compartment is conducted to the spitzkasten S, being thereby utilized for the purpose of carrying the mineral values, as noted.

The above construction led to a design of greater simplicity, known as the "Hebbard" type of minerals separation machine,⁶ which consists of a long rectangular tank without any partitions, in which a number of agitators revolve, while air is injected under each impeller. In order to limit the agitation to the lower part of the machine, and to provide an area of comparative quiet in the upper part, a system of baffles is arranged above the agitators. As a consequence the froth is given a chance to separate in the upper portion of the rectangular tank, and flows off on both sides into lengthwise launders provided for the purpose. This, it will be seen, is a phase of operation similar to that of pneumatic machines where the froth, formed in the one compartment, flows over into launders.

This machine no doubt marks an important step⁷ in

⁵Bull. A. I. M. E., Sept., 1916.

⁶Ibid., p. 1644

⁷As recorded by Laist and Wiggin in an article, "Flotation Concentration at Anaconda, Mont.," Bull. A. I. M. E., Sept., 1916, p. 559, this machine was a failure on account of too much disturbance in the upper part of the machine for the proper removal of froth. They do not say whether the top position was baffled or not.

the development of the Minerals Separation flotation system. The simplicity of the machine is remarkable and does away with the bulky spitzkasten and the mechanical device for removing the froth. The floor room required for the machine is thus reduced to a minimum which is an important point in mill practice.

2. **Janney Mechanical-Air Machine.** The mechanical agitation in this machine⁸ is obtained in the same manner as in the Janney straight mechanical machine. There is a continuous circulation of pulp through the mixing chamber and over the air mat. From the emulsifier E, Fig. 4, the pulp and oil, thoroughly beaten together, pass to the agitating chamber A of the first machine through a pipe P. From here it overflows continuously into the spitzkasten S. The froth flows over the gate G, while the un-retained pulp flows over the gate B, which controls the height of pulp in the "spitz." From here the pulp flows through a pipe, R, to machine No. 2, and so on down through the series.

The bottom D of the spitzkasten is a cast-iron pan, divided into three compartments, the whole being covered by four layers of cross-stitch palma twill. The pan is divided into three compartments so the air may be regulated to meet the varying hydraulic head

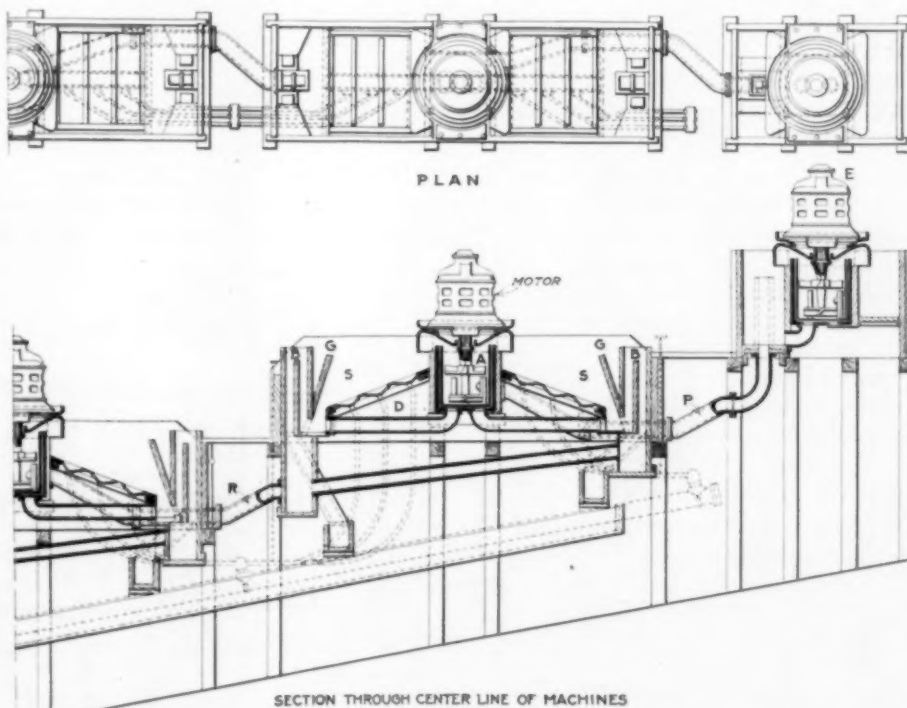


FIG. 4.—JANNEY MECHANICAL-AIR MACHINE AND EMULSIFIER

within the spitzkasten, as a pressure of from four to five pounds is required.

These machines may be installed end to end, or side by side, usually in a series of one mixer, or emulsifier, and five flotation cells. The latter arrangement is used in small plants, as it is more compact: the floor space required is approximately 5 by 16 feet per unit, with a drop of 3 feet between cells. For the end-to-end arrangement the floor space required is approximately 4 by 16 feet, with a drop of 3 feet between cells.

3. The Kollberg-Kraut machine is a complete unit,

⁸Catalog, Stimpson Equipment Co., Salt Lake City, Utah.

requiring no blower, air compressor, or pre-agitation. See Fig. 5, which shows details of this machine as used at the Burro Mountain Mill,¹ Tyrone, New Mexico.

The feed enters at one end of the machine through a five-inch feed pipe F, the tailings being discharged at the opposite end through a four-inch pipe T, while

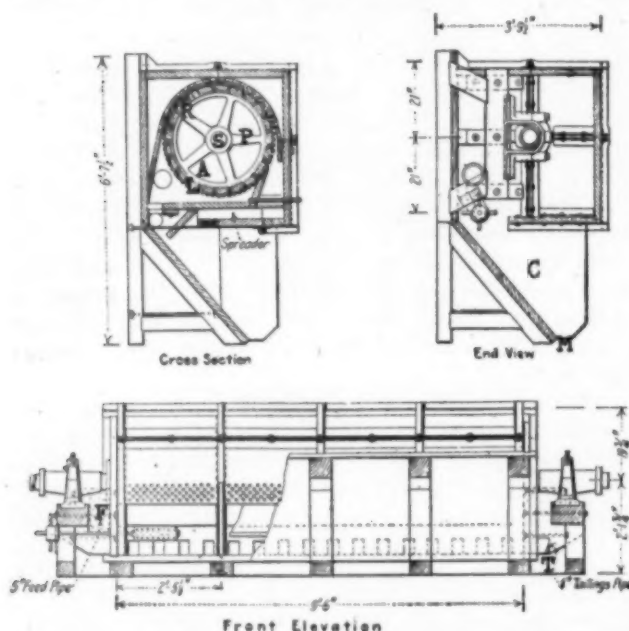


FIG. 5.—DETAILS OF THE FLOTATION MACHINE AT THE BURRO MOUNTAIN MILL

the concentrate is discharged over the lip M of the frothing chamber C into a suitable launder. An adjustable level-control device is provided which maintains the proper level of pulp in the machine, which in return furnishes the correct height of the bubble column in the frothing chamber.

The machine consists of a cylindrical housing about 10 ft long and 30 inches in diameter. Inside the aëration chamber A is located a rotor R which consists of a 3 $\frac{1}{8}$ -inch steel shaft S, on which is mounted four cast-iron spiders P for carrying the lagging and riffles L of the rotor. The lagging forming the periphery of the rotor is so spaced as to leave a $\frac{1}{8}$ -inch opening between each piece. There are 16 of these pieces and each is provided with four hard-wood or steel riffles, which run the entire length of the rotor. The rotor revolves at 180 r.p.m. and has a clearance of three-eighths inch between its outside periphery and the inside surface of the aëration chamber.

The rotor shaft passes through the two end plates of the machine by means of two air ducts, of ample size

to furnish all the air necessary to thoroughly aërate the pulp as it is revolved. There is no leakage of air through these air ducts, but a continuous influx of air from the atmosphere which is discharged by centrifugal force through the air slots between each of the 16 pieces of riffled lagging forming the periphery of the rotor. It immediately comes in contact with a thin film of pulp which has been circulated by the rotor, and the revolving pulp is thoroughly aërated in the space between the outside periphery of the rotor and the inside surface of the aëration chamber.

The housing can be removed for replacing the riffles, which last from four to six months. The floor space required by this machine is 4 feet by 14 feet, and from 6 to 8 hp. is required to operate it.

III. PNEUMATIC FLOTATION MACHINES

The first application of pneumatic flotation for the treatment of ore was made at the mill of the National Copper Company at Mullen, Idaho, which was designed and constructed by J. M. Callow.² Construction was started on Aug. 14, 1913, and the plant went into operation about April 10, 1914. The Callow pneumatic system was a success from the start, and it is interesting to note that it had been so thoroughly thought out in its initial design that during three years of operation little or no change has been made. Other machines operating on the pneumatic principle, in general, have also been successful.

1. The Callow Pneumatic Machine. Fig. 6 illustrates the various elements composing the Callow process in general.

In the mixer A, operated by compressed air, oil, air and water are mixed and emulsified; the same type of

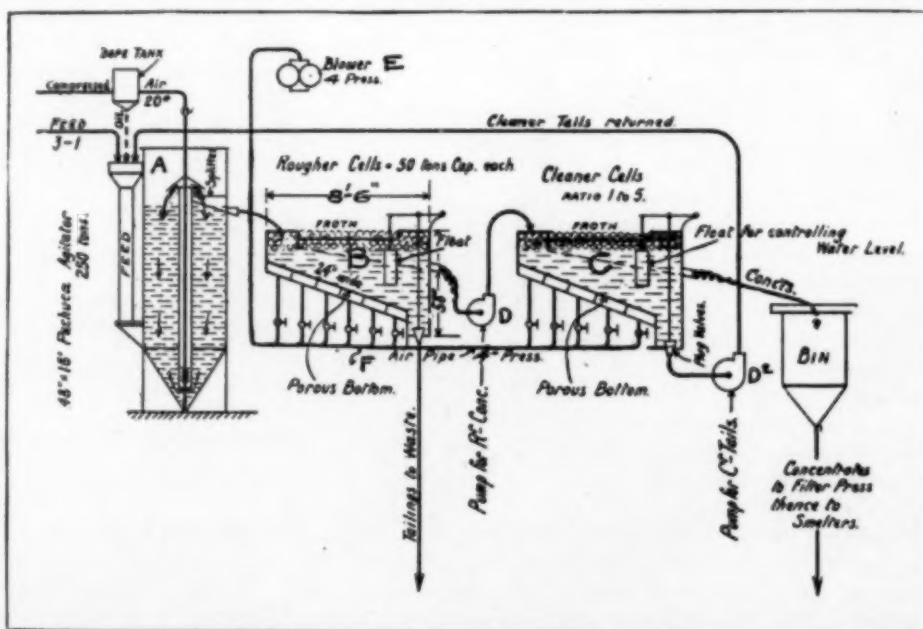


FIG. 6.—CALLOW PNEUMATIC FLOTATION PROCESS

apparatus (Pachuca tank) is in common use in cyanide works. In case the oil or frothing agent can be fed into the crushing machine or tube-mill, this mixer can

¹"The Burro Mountain Concentrator," by L. C. Blickensderfer, *Eng. and Min. Journal*, Jan. 14, 1917.

²"Notes on Flotation," Historical sketch, *Bull. A. I. M. E.*, No. 108, p. 2321-2339, Dec., 1915. "Callow Pneumatic Flotation Process," *Met. and Chem. Engrg.*, v. 13, p. 571-572, Sept. 1, 1915; *Eng. and Min. Jour.*, v. 100 p. 919-923, Dec. 4, 1915.

be dispensed with, the tube-mill discharging direct into the separatory cell. It has been conclusively proved that agitation of the pulp, before subjecting it to the bubble column, is not necessary to successful flotation by the pneumatic method.

The initial or roughing cell B consists of a tank about 9 feet long over all, and 24 inches wide, with a bottom inclined at from 3 to 4 inches per foot, 20 inches deep at the shallow end and 45 inches deep at the other end. It may be built of either wood or steel, but wood construction is preferable.

Fig. 7, shows the cell in detail as used at Inspiration.¹¹ The bottom of the tank consists of a porous medium made of four thicknesses of loosely woven canvas twill," properly supported by a backing of perforated metal to prevent its bulging under air pressure. Through this porous medium compressed air is forced by the blower E, Fig. 6. The space underneath this porous medium is subdivided into eight compartments, each connected by an individual pipe and

of the side gutters to the pump D (Fig. 6) and then to the cleaner cell C, of the same construction as the rougher. Usually one cleaner serves four roughers and operates under a slightly lower air pressure.

A given number of cells may be run either in parallel or in series without any sacrifice in capacity. On some ores the series-treatment gives a slightly cleaner tailing; on others it does not. Usually two cells in series is sufficient. In a heavily mineralized ore the series arrangement is a decided advantage, as the possibilities of any particle of mineral to escape are lessened.

2. The Flinn-Towne Machine. In Fig. 8 is seen a single cell of this type. It operates on the pneumatic principle, although the application is somewhat differ-

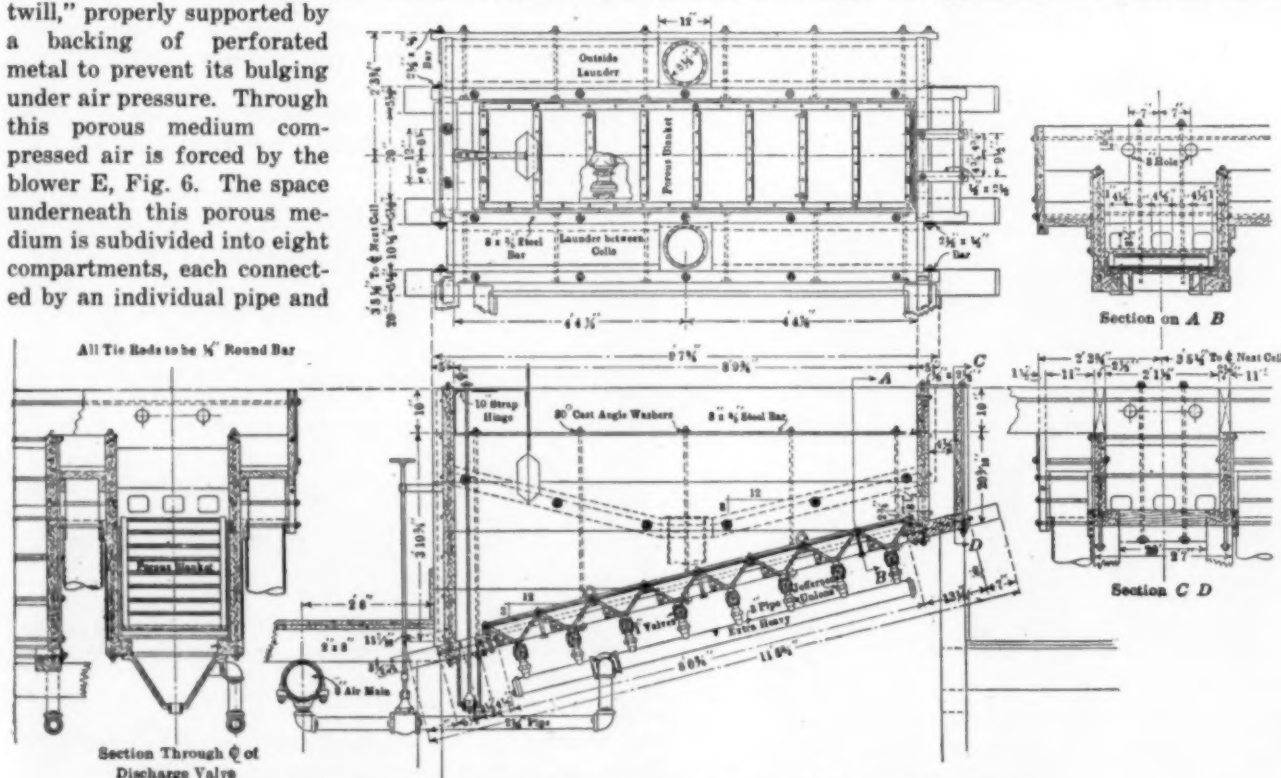


FIG. 7.—DETAILS OF CALLOW PNEUMATIC FLOTATION MACHINE

valve to the air main. By this means the pressure in each compartment can be regulated to correspond to the varying hydraulic head within the tank, and so discharge a uniform amount of air throughout the length of the tank. A pressure of from 4 to 5 pounds is generally used, each square foot of porous medium requiring from 3 to 10 cubic feet of free air per minute.

Each longitudinal edge of the tank is provided with a lip and an overflow gutter for the reception of froth to be discharged. The lower end of the tank is furnished with a spigot discharge fitted with a float-operated plug valve to maintain a uniform water-level within the tank and thus, in turn, maintain a uniform and constant discharge of froth under all varying conditions of feed incident to practical milling operations. The water-level may, of course, be varied, but is usually maintained at from 10 to 12 inches below the level of the overflow lip. The tailing is discharged through the spigot and the frothy concentrate is conveyed by means

ent from that of the Callow system. The cells are constructed in the shape of cylindrical tanks, 24 inches in diameter by 6 feet 6 inches in height, the bottoms of which are formed by the porous medium. The feed enters near the top and near the center of the cylinder D through an adjustable disc E, while the tailings leave the machine through a center hole F in the porous medium. The goose neck G, which extends up above the porous bottom, is for discharging the tailings; it also controls the height of pulp-level in the cell A. Sands that are too heavy to be carried up the goose neck may be drawn off through the pipe R. Through the pipe P, air under pressure enters the chamber C, and is injected into the pulp through a carborundum disc (canvas may also be used). The concentrate froth overflows around the circumference of the cell into the launder K.

It is evident that this cell would be limited in capacity on account of its round shape. If a large unit were built it would be bulky and also the distance the froth would travel to leave the machine would be too great for good work.

¹¹"The History of Flotation at Inspiration," Rudolf Gahl, *Bull. A. I. M. E.*, Sept., 1916.

¹²This form of bottom was also first used by Callow and is the standard bottom used at present.

IMPROVEMENT ON FLINNE TOWNE MACHINE

With this apparatus as a suggestion Messrs. Cole¹³ and Bergman have designed an apparatus which is an

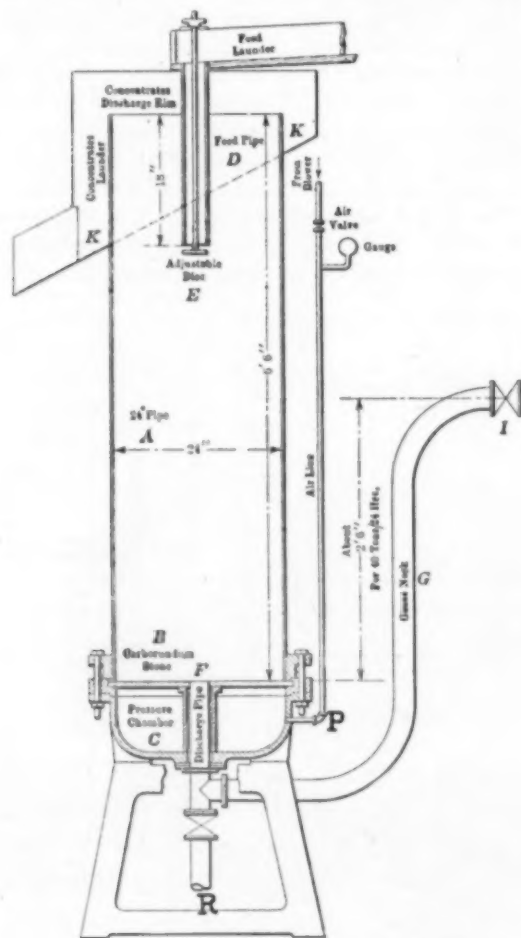


FIG. 8. FLINNE TOWNE MACHINE

improvement on the Flinne Towne machine. It, however, embodies many of the principles of the latter.

(To be continued.)

Gas Chemists of Bureau of Mines Transferred to War Department

By order of President Wilson dated June 29, 1918, all of the activities of the Government concerned with the investigation and manufacture of poison gas for war purposes were transferred on July 1 to the control of the War Department. The research work on this subject was begun some months ago under the direction of the Bureau of Mines which established a chemical section at the American University, Washington. In making the transfer, President Wilson acknowledges the excellent work done by the Bureau in establishing and maintaining this work, but states that a more efficient organization can be effected by concentrating all of the facilities for offensive and defensive gas operations under the newly organized Division of Gas Warfare. The gas experiment work is now under the direction of Major General William L. Sibert who was recently returned from France where he commanded the First Division of the regular army.

¹³"The Advent of Flotation in the Clifton-Morenci District, Arizona." By David Cole. *Bull. A. I. M. E.*, Sept., 1916.

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After-the-War Program of Vickers (Ltd.)

This firm is now establishing a market for sewing machines to be produced at one gun factory by the 1700 general service machine tools there available. A study of the proper reduction of waste has led to the installation of a plant for making wooden ware, which is to be rapidly expanded, and which will get its raw material from their shipyards even after they have been converted from the making of war ships to those for the mercantile marine. Another plant is to make automobile accessories. Vickers have also acquired the Bosche Magneto Works and partial control of the British Westinghouse Co.

The Role of Complex Salts as Electrolytes in Plating and Refining Baths*

BY REGINALD S. DEAN AND MING YI CHANG

IT HAS long been known that complex salts gave smoother and more adherent deposits than could be obtained from equivalent concentrations of simple salts. The reason for this as commonly given is that the deposit is the result of a secondary reaction, the metal being precipitated rather chemically than electrolytically; e.g., the silver from a potassium-silver cyanide solution is assumed to be deposited by the preliminary discharge of the potassium ion and subsequent deposition of the silver by the potassium formed. This explanation seems a bit forced since there is no *a priori* reason why the silver deposited by chemical action of the alkali metals should be

concentration of the ion being discharged, or, more generally, the greater the potential difference between the deposit and the bath the more nearly amorphous will be the deposit. He says:

"It is well known that silver and copper precipitate in a more nearly amorphous form from potassium cyanide solutions than from nitrate solutions. It is not a case of secondary deposition giving a good deposit as has sometimes been assumed because the decomposition voltages of the copper and silver cyanide solutions used in plating are lower than the decomposition voltage of the corresponding pure cyanide solution. As we can get a plating deposit of silver from a silver nitrate solution under suitable conditions it is obvious that there is no fundamental difference introduced by the formation of a complex salt. So far as the facts are known they can be formulated in the statement that the deposit is more finely crystalline the greater the potential difference between the metal and the solution."

The experimental evidence favors this theory for simple salts, at least so far as moderately large ion concentrations are concerned, as is shown by the accompanying pictures (Figs. 2, 3 and 4) of the

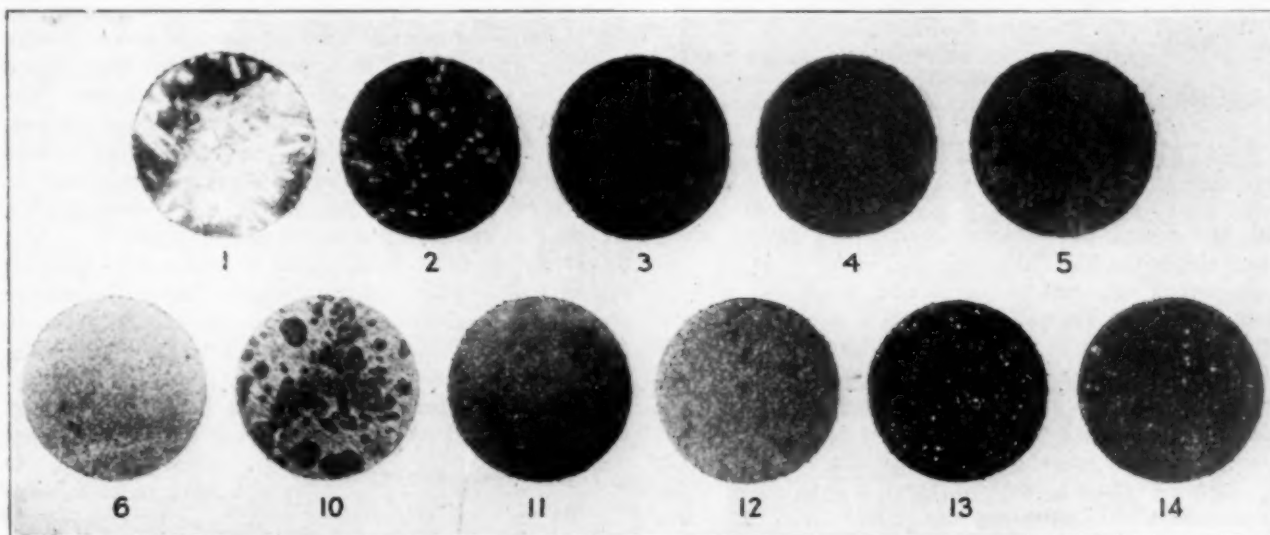


Fig. 1—Silver deposit on magnesium; $\times 60$ diameters.

Fig. 2—Silver deposit from $\frac{N}{100}$ AgNO_3 ; $\times 60$ diameters.

Fig. 3—Silver deposit from $\frac{N}{1000}$ AgNO_3 ; $\times 60$ diameters.

Fig. 4—Silver deposit from $\frac{N}{10000}$ AgNO_3 ; $\times 60$ diameters.

Fig. 5—Silver deposit from Ag_2O ; $\times 60$ diameters.

Fig. 6—Silver deposit from a solution made by dissolving AgCl in KCN ($\text{AgCl} + 2\text{KCN} = \text{KAg}(\text{CN})_2 + \text{KCl}$); $\times 60$ diameters.

Fig. 10—Copper deposit from copper tartrate; $\times 60$ diameters.

Fig. 11—Copper deposit from copper tartrate with addition of Na_2SO_4 ; $\times 60$ diameters.

Fig. 12—Copper deposit from copper tartrate with addition of $\text{Al}_2(\text{SO}_4)_3$; $\times 60$ diameters.

Fig. 13—Cadmium deposit from 0.1 molar CdCl_2 ; $\times 60$ diameters.

Fig. 14—Cadmium deposit from 1.0 molar CdCl_2 with addition of NaCl ; $\times 60$ diameters.

more smooth and adherent than the electrolytic deposit. Certainly the chemical deposit obtained by the replacement with iron is neither smooth nor adherent and that obtained with magnesium is even more coarsely crystalline, as shown by the photomicrograph in Fig. 1.

Glaser¹ has suggested that the beneficial action of the complex tartrates may be due in part to the reducing action of compounds formed from them during electrolysis. Bancroft thinks that this can possibly be extended to the effect of complex cyanides. Good deposits, however, may be obtained from many complex solutions which show no reducing action; e.g., the silver-ammonia complexes.

A third very interesting theory has been proposed by Bancroft.² It is based upon the fact that the crystallinity of a deposit decreases with decreasing

deposits obtained from hundredth, thousandth and ten-thousandth-normal solutions of silver nitrate. Whether this evidence can be extrapolated to solutions containing so little silver ion as the complex cyanides can not be definitely stated. An attempt to determine this experimentally was made, using violently stirred suspensions of silver oxide, chromate, chloride, thiocyanate and sulphide. In this way concentrations of silver ion comparable to that in the argenticyanide were maintained without the additional influence of a complex salt. The anode used was pure silver foil while the cathode was a highly polished copper strip. The current used was about 0.05 ampere and the voltage about 2.6; the electrode area was 2.5 square centimeters.

The deposit obtained from the silver oxide is shown in Fig. 5, and is seen to be somewhat more crystalline than that obtained from ten-thousandth-normal silver nitrate which is about what would be expected from the solubility of the silver oxide. We found it im-

*Contribution from the Metallurgy Laboratory of the University of Pittsburgh. Experimental work from the thesis of M. Y. Chang.

¹Glaser *Zeit. f. Elektrochemie* 7, 386 (1900)

²W. D. Bancroft, *Journ. Phys. Chem.* 9, 290 (1905)

possible to obtain a deposit from silver chromate or any of the less soluble salts even after the addition of enough potassium nitrate to make a 10 per cent solution. If, however, cyanide was added to any of these suspensions a solution was obtained which must obviously have been less concentrated in silver ion than

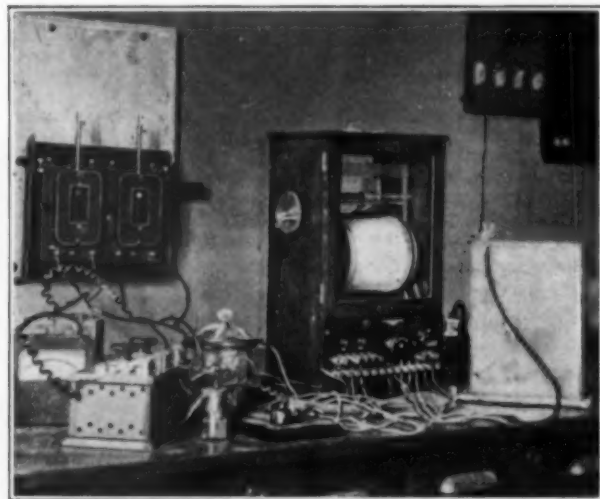


FIG. 7.—LEEDS AND NORTHRUP TRANSITION-POINT APPARATUS SET UP FOR THE DETERMINATION OF DECOMPOSITION VOLTAGE

the suspension, but which, nevertheless, gave a good silver deposit (see Fig. 6).

It is not particularly surprising from the experimental point of view that no deposit is obtained from solutions so dilute in silver ion as silver chloride, since the decomposition voltage increases with the dilution, and at dilutions as great as that of insoluble salts exceeds the hydrogen decomposition point and hence the current efficiency drops practically to zero. But why do we obtain a deposit from a cyanide solution which certainly contains less silver ion than the chloride solution, since we have no reason to believe that the decomposition point of an ion depends on anything but the concentration of that ion? These facts may be explained by the secondary deposition theory since the deposition in that case is due to the discharge of the K^+ ion, which, being present in high concentrations, may

but the K^+ ion, and the behavior of the latter is exactly what would be expected since the concentration of K^+ ion is much larger in $KAg(CN)_2$ than in a corresponding KCN solution, the extreme weight of the anion in the complex salt causing practically complete ionization.

Experiments to determine if the deposition of silver from a cyanide solution took place at the voltage which would be expected from the concentration of potassium ion were made. The apparatus employed was novel and will be described in some detail. It was essentially an adaptation of the Leeds and Northrup transition point instrument for the determination of decomposition voltage. The voltage was read on the difference couple galvanometer scale, the galvanometer being shunted directly across the cell with a graphite resistance in series. The graphite resistance is essential, and to insure constancy is best made in the manner developed by V. H. Gottschalk and R. S. Dean especially for this kind of work at the Missouri School of Mines. A plate of frosted glass or unglazed porcelain serves as a base and the lead-pencil line is drawn across it, the contacts being made with tin foil and screw clamps, and the whole placed in a dessicator over phosphorus pentoxide and the wires led in through a stopper. The use of a dessicator is much more satisfactory for preventing the absorption of water than any kind of wax or lacquer. The resistance necessary depends on the cell and electrodes used, but should be several megohms. In order to get readings which can be traced it is best to set the beam of light as far to the left as possible and then place about three volts across the galvanometer circuit and regulate the graphite resistance so as to get a readable value. The current is read by means of the thermocouple galvanometer and a 0.001-ohm shunt, the voltage across the shunt being balanced by the drum potentiometer. In the use of the apparatus

the current is gradually increased by means of a potentiometer and the voltage and current followed by the tracing pen. The connections and general construction of the apparatus are made clear by the photograph and

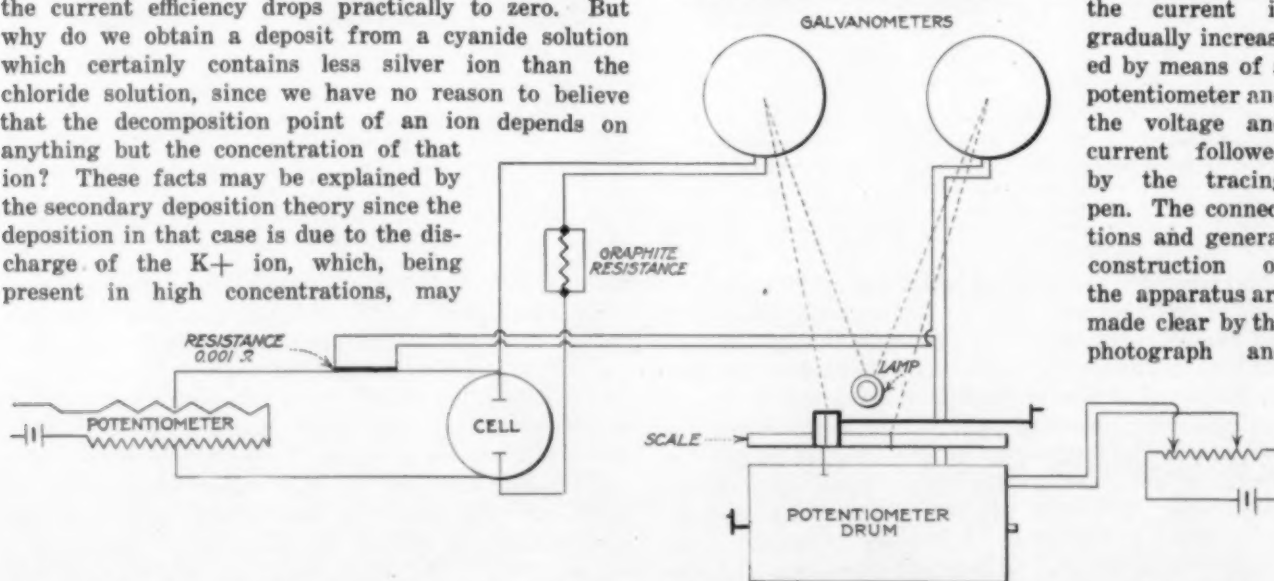


FIG. 8.—DIAGRAM OF LEEDS AND NORTHRUP TRANSITION-POINT APPARATUS ARRANGED FOR DECOMPOSITION VOLTAGES

readily reach its decomposition voltage long before the extremely dilute silver ion. Bancroft notes that the decomposition cannot be secondary, since the $KAg(CN)_2$ has a lower decomposition voltage than the corresponding KCN solution. This argument, however, is not valid since it is not the Ag^+ ion, which is discharged,

diagram. (Figs. 7 and 8.) The curves obtained with this apparatus from tenth-normal silver nitrate, 0.275-normal potassium nitrate, and a potassium-silver cyanide solution 0.25-normal with respect to potassium and 0.1-normal with respect to silver are shown in Fig. 9. The potassium nitrate

solution was made of such strength that, assuming 75 per cent ionization for KNO_3 and KCN and 100 per cent for KAg(CN)_2 , the concentration of potassium ion in the two solutions would be the same. The results show that the decomposition voltage of the KAg(CN)_2 is practically what would be expected from the concentration of potassium ion, and bears no relation to either the total concentration of silver or concentration of silver ion. This proves that the deposition of silver from complex cyanide solutions is due to the discharge of potassium ion.

There is little question then that the deposition is secondary but this explanation fails to say why we cannot accomplish the same result with a silver chloride suspension containing potassium nitrate. The reason is evidently that in so dilute a solution of silver as the chloride, the potassium liberated decomposes only water instead of silver nitrate, due to mass action, while in the case of the argenticyanide the un-ionized silver which is present in relatively large concentrations

Admitting, however, that the deposit is secondary when obtained from most complex solutions we are still uninformed as to why secondary deposition gives a smooth deposit. As previously noted, magnesium gives a very crystalline deposit so we must look elsewhere than the mere deposition by a metal of high solution-tension for an explanation of the phenomena. The presence of large crystals is due to the tendency of crystals to grow; i.e., in the case of silver the next atom of silver tends to deposit on the silver already deposited. Now in secondary deposition there is no opportunity for crystal growth since an atom of alkali metal is deposited and before it has an opportunity to grow is dissolved with the formation of silver; and since there is no other alkali metal present the next atom is deposited at random and in this way a smooth deposit is obtained. The failure to obtain a smooth deposit with magnesium is readily explained on this basis since the first bit of silver deposited forms with the still exposed magnesium a small cell in which the magnesium goes into solution on the one hand and the silver is deposited on the other.

In order to test these conclusions a solution of copper tartrate in tartaric acid was prepared by adding tartaric acid to copper acetate. The solution so obtained was about tenth-normal with respect to copper but was evidently quite low in copper ion content since the copper tartrate did not precipitate. A solution of this kind was electrolyzed using copper anode and cathode, the potential across the cell being maintained at three volts. Despite the very low concentration of copper ion the deposit obtained was very crystalline which confirms our conclusion that the presence of a metal of lower solution-tension is essential to the formation of an amorphous deposit. If now sodium sulphate was added to the copper tartrate solution and the electrolysis carried on under identical conditions, a quite smooth deposit is obtained. The addition of aluminium sulphate produces a similar result. These deposits are shown in Figs. 10, 11 and 12.

Still further results were obtained with cadmium solutions using a molar solution of cadmium chloride with the addition of NaCl and a tenth-molar solution without the addition of NaCl . These two solutions contain very nearly the same concentration of cadmium ion but the deposit from the solution containing the NaCl was markedly less crystalline. These deposits are shown in Figs. 13 and 14.

We may then define the conditions under which a complex solution will give an amorphous or nearly amorphous deposit.

(1) The presence of another metal than the one being deposited, which other metal must have a notably lower solution-tension than the one being deposited.

(2) A sufficiently complex salt that the concentration of the ion being deposited will be so low that its discharge voltage will be above that of the secondary metal.

We are indebted to Prof. V. H. Gottschalk of the Missouri School of Mines and Metallurgy for the suggestion of trying Bancroft's theory by the use of suspensions of insoluble salts.

The experiments quoted above are from the thesis of Mr. M. Y. Chang at the University of Pittsburgh.

Pittsburgh, Pa.

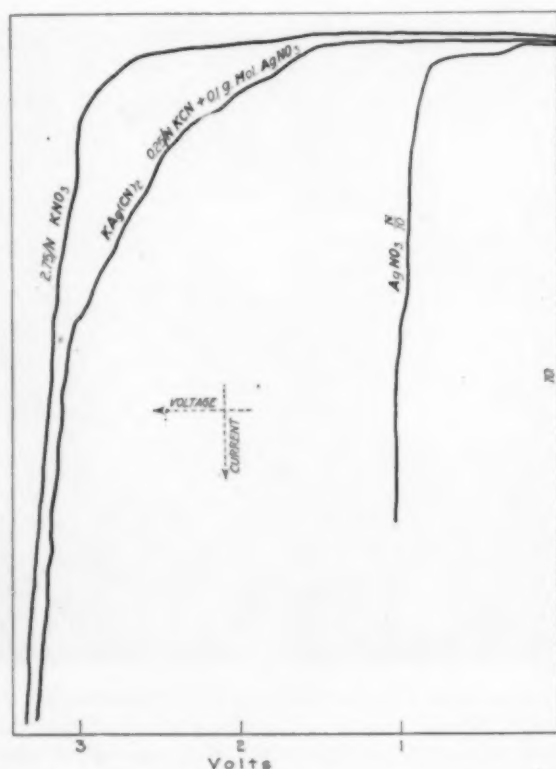


FIG. 9.—DIAGRAM OF DECOMPOSITION VOLTAGE-CURRENT CURVES OBTAINED WITH LEEDS AND NORTHROP TRANSITION-POINT APPARATUS

is decomposed by the potassium. In other words the secondary reaction is not an ionic one but may be represented by the equation



or possibly



It follows that the real purpose of a complex solution is to furnish a concentrated solution of the metal, but a dilute solution of its ion; further the complex salt must have so little heavy-metal ion that the discharge of the alkali-metal ion will take place first.

Development of an Electric Furnace for Annealing Treatment and Forging of Steel*

BY WIRT S. SCOTT

EXPERIMENTAL work by the Westinghouse Electric & Manufacturing Co. on register-type furnaces for forging has continued through several years. Our first investigation was with a granular graphite resistor bed 9 inches wide, 8 inches deep, by 36 inches long, for heating a furnace having an opening 36 inches wide, 24 inches deep by 10 inches high. Other resistor materials consisting of granular graphite, coke, charcoal, and finally these materials in various combinations, also in combination with carbon blocks, were given exhaustive tests, always with the same general result. It is sometimes of equal importance to know the reasons for failure as for success; hence it should be of interest to know the reasons for discarding all of the above resistor materials as being unsuitable for an electric forging furnace.

LIMITATIONS OF CARBON RESISTORS

To secure even moderately successful results, it was found that the resistor material must be of the purest carbon or graphite. It is quite difficult to obtain a supply sufficient for operating furnaces.

If there is any slag or ashes left from the combustion of the resistor, it remains in the bed, so that the relative proportion of such material is gradually increasing with time, causing an increase in the resistance of the furnace. If the slag or ash is fusible at the temperature of the resistor bed, a clinker will be formed which very rapidly extends through the granular mass, resulting in a rapid increase in resistance and consequent failure to heat.

When the furnace was maintained for a considerable length of time at sufficiently high temperature to turn out heated steel at 1800 deg. F., we found that the temperature in the bottom of the resistor bed exceeded the safe limits of refractory materials. With a temperature of 1800 deg. F. on the surface of the bed, it was found that the temperature at the bottom was approximately 3600 deg. F. This great temperature difference is due to the electrical characteristics of carbon in that it has a large negative temperature resistance coefficient, that is to say, as the temperature increases, the resistance decreases. It is evident that the carbon in the bottom or at the center of the bed will operate at higher temperatures than the surface, which has an opportunity to radiate its heat to the surrounding air and chamber. An increase in temperature at any given part, lowers the resistance through that part, which in turn causes more current to flow, and so on, the temperature gradually increasing with the current. Conditions tend to become stable at any very high temperature, but greatly in excess of that which may be safely withstood by any refractory material now available.

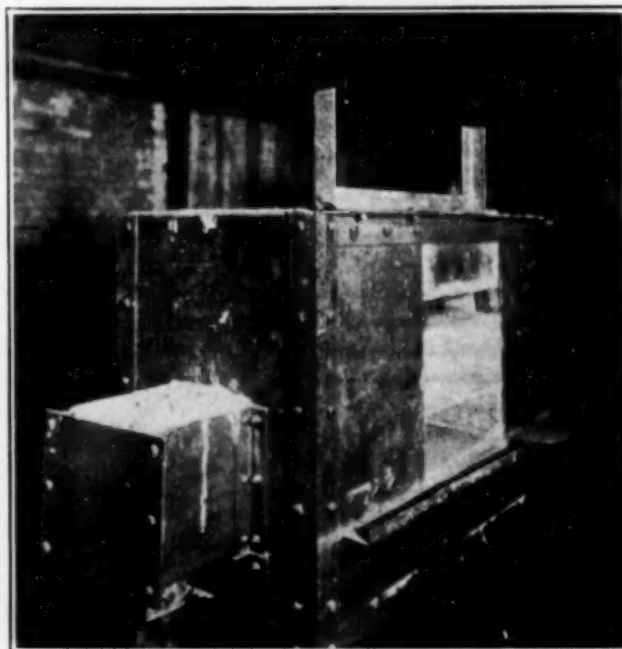
In heating a piece of work in an ordinary fuel-fired furnace, heat is transferred to the work by conduction from the hot gases and by radiation from the walls. The walls are maintained at a temperature higher than

that desired at the work because they are continuously swept by the hot gases. In an electric furnace we do not have this action to heat all of the surface uniformly.

If heat is generated only on the floor of the hearth, the side-walls and roof must obtain their heat by direct radiation. If cold pieces of metal are laid closely over the surface of the resistor hearth, they will interfere with the radiation of the heat to the walls and roof directly in proportion to the amount of hearth surface they cover. This would mean that the work would be heated from the under side only, and instead of receiving heat from the walls and roof, it would be giving off heat, thereby always having a great difference in the temperature in the two opposite sides. In order to heat the upper surface to a sufficiently high temperature, the lower surface must be overheated.

PROPERTIES OF SILICON CARBIDE

During the latter part of 1916, we began our experiments in using carbide as a resistance material. A study of the chemical and physical properties of silicon



ELECTRIC RESISTANCE ANNEALING FURNACE

carbide led us to believe that it possessed desirable qualities essential to a suitable resistor for an electric forging furnace, but also indicated that there were many difficulties to be overcome which were real problems in themselves.

The temperature of formation of this resistor is 1950 deg. C. (3542 deg. F.). The temperature of decomposition is 2220 deg. C. or 4018 deg. F. There is no oxidation of this material in pure oxygen at 1000 deg. C. (1800 deg. F.). From 1500 deg. to 1800 deg. C. (2732 deg. F. to 3272 deg. F.) oxidation is very much retarded by the fused silica coating. Neutral or reducing gases, such as carbon monoxide, nitrogen and hydrogen have little or no action.

The hardness is between the ruby and the diamond. The specific gravity is 3.12 to 3.20. Based on a specific gravity of 3.20 the weight of the solid block without pores is 199.7 lb. per cubic foot or 0.116 lb. per cu. in.

*A paper presented before the Assn. of Iron and Steel Electrical Engineers, Pittsburgh, Apr. 20, 1918.

In order to adapt silicon carbide to its various uses the tensile strength of the bonded articles may be made to vary between wide limits. In ceramic-bonded articles where the bond does not introduce objectionable physical or chemical properties, a tensile strength of 1400 lb. per square inch may be attained. A sacrifice of resistance to heat changes and chemical actions affecting ceramic articles must be expected with high tensile strength.

The resistor is a conductor of the second class. At ordinary temperature its conductivity is very low, being several times less than carbon. With increase of temperature its conductivity increases very rapidly, as it has a large negative temperature resistance coefficient.

The resistivity of the bricks varies with differences in porosity and chemical composition. However, it is interesting to note that at temperatures above 1800 deg. F. the resistivities have approximately the same value. A general idea of the variation of the resistance will be obtained from the following:

Deg. F.	Ohms Per Cu. Cm.
75	50
1000	18
1800	3.7
2550	0.65

EXCELLENT QUALITIES OF SILICON CARBIDE AS A RESISTOR

From a resumé of the above, it may be seen that this resistor material possesses the following excellent qualities: (1) The temperature of decomposition is above 4000 deg. F., which is approximately 1500 deg. higher than the hottest temperature required at the surface of the resistor. Due to the construction of furnace employed, the atmosphere in the furnace chamber is non-oxidizing, and under these conditions the resistor is non-consuming. (2) It may be molded in block form, allowing the heating element to be placed in any desirable position around the heating chamber. (3) Due to its high tensile strength, the roof of the heating chamber, as well as the hearth may be made out of these resistor blocks. (4) The fact that it has a large negative temperature resistance coefficient may be utilized in the control of the furnace temperature by controlling the current input to this resistor material.

DESIGN AND TEST OF FIRST EXPERIMENTAL FURNACES

The first complete furnace of this type which we built and which gave promise of success had an outside dimension 41 in. wide across the front, 27 in. deep and 48 in. high. It was designed with two working chambers 7 in. long by 5 in. high, for the heating of 50 lb. of steel per hour to 1800 deg. in each chamber, or a total of 100 lb. per hour for the furnace. The resistors consisted of blocks having a cross section of $4\frac{1}{2}$ in. by $2\frac{1}{2}$ in. passing above and below the working chamber. The resistors terminated in electrode chimneys filled with granular graphite, into which steel terminal plates extended, for external connections.

Owing to the high resistance of this type of furnace when cold, and due to the length of resistors used, a starting voltage of 220 volts was required, which was cut down in a few minutes time to 110 volts, and then gradually reduced until 60 volts was reached, which maintained the proper temperature.

The time required to bring the furnace up to an operating temperature of 1800 deg. F. was eight hours,

starting with the furnace cold. Owing to the great heat reserve capacity of the furnace, the time required in successive heatings was greatly reduced, depending upon the length of time the furnace was out of operation. In order to have the furnace available for immediate use, sufficient current was maintained on the furnace during the night to supply the radiation losses. On a 20-hour continuous forging test the average input during this test was about 18 kw. or 300 amperes at 60 volts. The charge during this test consisted of approximately four pieces of steel weighing six pounds total, each piece requiring an average of three heats, one from cold to 1800 deg. F., the other two from about 900 deg. F. to a final temperature of 1800 deg. F. The hourly output averaged 20 pounds heated from 70 deg. to 1800 deg. F. and 40 pounds from 900 deg. to 1800 deg. F.

No special attention was given to the thermal insulation of the furnace since that was of secondary importance, and a matter which could be taken care of at a later date, once we secured a suitable construction. Notwithstanding the light insulation that was used, a furnace efficiency of 41 per cent was maintained. The furnace ultimately proved unsatisfactory due to unequal heating of the two chambers.

The results of the tests proved conclusively that a temperature of 1800 deg. F. could be obtained and maintained for an indefinite period so far as the resistor material was concerned. Hand control was used entirely in the operation of this furnace, in conjunction with a circuit breaker for tripping the circuit should the current increase beyond a safe operating value.

DESIGN AND TEST OF SECOND EXPERIMENTAL FURNACE

The second complete furnace had an overall dimension of 46 in. wide, 38 in. deep by 48 in. high, inclusive of an iron stand 12 in. high. The radiating surface was approximately 81 sq ft. The resistor consisted of two blocks $2\frac{1}{2}$ by $4\frac{1}{2}$ in. cross-section by 9 in. in length, connected in parallel, one over the heating chamber, and one underneath $2\frac{1}{2}$ in. apart, forming a heating chamber 7 in. wide, 11 in. deep by $2\frac{1}{2}$ in. high. The resistors were surrounded and imbedded in a refractory lining made up principally of a crucible clay and a graphite mixture. Surrounding this extremely hot area, silica bricks were used, backed up by ordinary fire bricks.

Electrode chimneys or wells were used very much the same as with the first furnace. The electrodes consisted of granular graphite and an amorphous carbon rod 4 in. square by 20 in. long embedded in each electrode well, and extending upward from near the steel terminal plate at the bottom of each well to the ends of the two resistors. The granular graphite insures electrical contact between the resistor blocks and the carbon block, and between the carbon block and the terminal plate. A cool terminal is thus obtained. The heat insulation on the outside of the furnace consisted of $4\frac{1}{2}$ in. of high-grade insulating brick all around, except opposite the electrode walls and around the door. Thin sheet-steel held in place by angle-iron and tie-rods clamped the insulating bricks together.

The starting voltage on this furnace was 75 volts, and the time required to raise the temperature of the heating chamber to a forging temperature of 1800 deg. F. was two hours. The power required at full load was 10 kw. or approximately 300 amperes at 33 volts. At no load,

a consumption of 5 kw. or 200 amperes at 25 volts obtained. This corresponds to an efficiency of 50 per cent.

The longest continuous run extended over a period of 15 days, or 370 hours, the furnace being maintained continuously at a forging temperature of 1800 deg. F. After these tests, an examination of the resistors was made, but no perceptible effect due to heating could be determined.

The control equipment consisted of a 110-volt transformer with knife switches for obtaining starting voltage, and interlocked magnet switches, push-button-operated, for obtaining the required running voltage. A circuit breaker was used as in the first case for protecting the furnace against an increase in current above the operating value.

The first furnace to be placed in continuous operation under actual shop conditions was made early in 1917. This furnace, a duplicate of the one last described, was installed in the tool-forging shop of the Westinghouse Electric & Manufacturing Company, and while it was considered that the furnace was still in its experimental stages, it was essential that we gain the experience of knowing how it would stand up under regular shop conditions.

Several failures of the furnace were recorded, but in each case the failure was due to the improper functioning of the control equipment which we were developing and experimenting with at that time. This furnace has been in operation for a period of one year, with highly encouraging results. Many runs have been made of continuous operation for periods of 400 and 500 hours, forging high-speed steel to 1850 deg. F. and drop-forging at 2200 deg. F. without any records of resistor failure, or any perceptible deterioration in the resistor due to the high operating temperature. One run of 500 hours was made at a temperature of 2650 deg. F. without experiencing any difficulty whatever.

For high-speed steel work, as it was found advisable to preheat the steel before placing it in the heating chamber, a preheating chamber was constructed under the heating chamber, consisting of an opening in the front of the furnace just below the lower resistor, into which the tools could be placed for preheating to eliminate strains that otherwise would be set up in the steel when placed in the furnace.

Another furnace has been built and placed in operation at our works, having a heating chamber 18 inches wide, 12 inches deep and 4½ inches high. The capacity

of this furnace is 20 kw., the starting voltage 220, and the running voltage 70. The efficiency is 60 per cent. This furnace is designed to operate on steel drop-forging requiring a temperature of 2300 deg. F.

DEVELOPMENT OF AUTOMATIC CONTROL EQUIPMENT

The control equipment at the present time is not completely automatic. That is to say, the furnace is not automatically brought up to the required temperature, but once the required temperature is obtained, then the control equipment will maintain that temperature within certain limits. Interlocked knife switches are used for connecting to the starting taps on the transformer.

As the furnace increases in temperature it is necessary to step down to lower voltages. The lower voltage taps are controlled by means of magnet switches operating over a relatively small percentage of the voltage range in order to obtain close temperature regulation.

The control equipment thus far developed is semi-automatic in its action, and may be used with entire satisfaction where the operator has a proper appreciation of the functioning of the control equipments. However, it is our intention ultimately to develop a complete automatic control equipment, which we hope to have perfected at an early date.

The general type of the furnace such as we have developed has a very wide application, but our ex-

periments thus far have been largely confined to forging, vitreous enameling, and for the reheating of glassware. A special furnace has been constructed and is successfully operated for the forming of lamp chimneys.

DISADVANTAGES OF FUEL-FIRED FURNACES FOR FORGING

Forging requires an operating temperature of from 1800 deg. to 2300 deg. F., depending upon the kind of steel used. One great difficulty with a fuel-fired furnace is not in the ability to obtain a sufficiently high heat, but in uneven heating. It is almost impossible to obtain uniform temperature throughout the entire chambers; consequently when the furnace is operated on a production basis, with several pieces being heated at one time, some of the pieces of work will be much hotter than others. The pieces in the hottest portion in all probability will heat much too rapidly, with the result that either the corners of the tools are burned before the material is heated clear through, or if it is removed before the surface burns, the center has not reached a suffi-



ELECTRIC RESISTANCE ANNEALING FURNACE

ciently high temperature. In this case the soft outside will yield much more readily than the hard inside, with the result that the outer particles will be torn asunder while the inside will be sound. The loss through oxidation takes place while the work is being heated in a fuel-fired furnace and also after it has been withdrawn and is being forged. The oxidation in the furnace is by far the larger of the two.

Annealing or softening is accomplished by heating steel to a red heat ranging from 1300 deg. to 1600 deg. F., depending upon the grade of steel, and then cooling it slowly. If the temperature is carried too high, it may leave the steel actually harder than the proper heat would leave it, besides running the risk of forming a scale. If scale is raised on a piece of steel, this scale will be a granular oxide of iron, and may spoil the tools used to cut it, sometimes changing the structure of the steel, making it brittle and causing it to crack in hardening. The effect of heat on steel may be noted by taking a bar of steel nicked in 10 or 12 places about $\frac{1}{4}$ inch apart, heating it in a fuel-fired furnace until the end is up to a good white heat, and then plunging it into cold water. In breaking off the pieces at each nick, it will be seen that characteristic changes have taken place in the steel. The end of the rod which had been overheated will be very open or crystalline in structure, the succeeding pieces becoming closer and closer in grain until one piece is formed possessing a close, even grain, the structure desired.

For every variation in the temperature there is a variation in grain of the steel. The effect of too high a heat is to open the grain, to make the steel coarse. The effect of irregular heat is to cause irregular grain, irregular strains and cracks in the steel.

ADVANTAGES OF ELECTRIC FORGING FURNACE

The furnace described offers an ideal solution for the conditions as above outlined, because:

- (a) Uniform temperature is obtained in all parts of the heating chambers.
- (b) The temperature found to produce the most satisfactory results may be obtained and maintained indefinitely.
- (c) A neutral atmosphere is obtained in the furnace chamber, thereby eliminating the major part of the oxidation of the steel.

For a given class of work subjected to a given heating operation the following conditions must apply.

1. The rate at which the work is heated is capable of infinite variation, but there must be some best sequence of heating.
2. The temperature difference between the heating medium and the work may be almost any value, but there must be some best value.
3. The maximum temperature to which the work is heated may be within fairly wide limits, but there must be some most satisfactory temperature to which each grade of steel should be heated.

An electric furnace permits of doing such experimental work as will exactly determine these factors; and, once they have been determined, it permits an operator to duplicate these results in operation: the ultimate feature in which we are interested.

Pittsburgh, Pa.

Société Coopérative for Belgium

In view of the critical situation which will result for Belgium through the disasters caused by the depredations of the enemy, his removing of tools, raw materials, manufactured products, etc., there has been created, with the coöperation of and under the control of the Belgian State, an organization having for its object the economical reconstruction of Belgium, entitled "Comptoir National Pour La Reprise de l'Activité Economique en Belgique (Société Coopérative).

This organization, in helping industry and trade, by enabling them to purchase the tools and all necessary raw materials, will not only reconstruct the economic situation of Belgium, but will put an end to the sufferings of the working classes by enabling them to start working in the reconstructed shops. All materials required for reconstruction are of interest to this organization, including materials for construction of buildings, leathers, textiles, farming implements, chemical products, wood machines, electrical materials, optical instruments, motor cars, vans, wagons, oils and greases of all kinds, refractory materials, etc. American manufacturers who have such materials to offer for export, either now or after the war, are requested to send catalogs and tariffs in triplicate.

Wood Alcohol for Motor Purposes

According to Consul General Albert Halstead, Stockholm, the war has naturally tended to cause neutral nations that are unable to procure their usual supplies of manufactured and other products to start to manufacture for the home market, and often to make substitutes. As a result these markets for American manufactures are certain to be found more competitive in many lines after the war, while in others to be unprofitable because of the success of domestic industry. However, a business man expressed the opinion the other day that perhaps 60 per cent of the newly established industries in Sweden would be unable to withstand foreign competition when it is resumed. From Germany systematic dumping was looked for, plans for which have already been made.

The impossibility of securing gasoline had almost driven automobiles from the streets of Stockholm. Recently, however, some taxicabs have reappeared which use wood alcohol instead of gasoline.

The newspapers of February 15 announced the formation of the Sulphite Mills Sales Co., with a capital of from \$53,600 to \$160,800 and representing 13 mills. Two are already using their waste lye for the manufacture of spirits, a number are soon to begin such operations, and others are planned. The production of the completed mills is said to amount to 15,000,000 liters (3,962,660 gallons) of 100 per cent pure alcohol a year. When all the mills are operated, their total capacity is calculated at 25,000,000 liters (6,604,440 gallons), and if all the Swedish sulphite mills were to produce spirits, the aggregate capacity would, it is said, reach 40,000,000 liters (10,567,100 gallons) annually. Continued Government assistance is expected for this industry.

Destructive Distillation of Oil Shales

Description of Products, Influence of Sulphur, Oxygen and Nitrogen Content—Commercial Possibilities

By JAC C. MORRELL AND GUSTAV EGLOFF

THE oil shale used in the present experiment was derived from the Green River formation, which belongs to the Eocene period consisting mainly of shale. The outcrop which consists of a greyish-white color, but really shows bands of white to grey, was not selected for retorting samples, but those which showed a brownish to black appearance on the freshly broken surfaces. This shale was tough and showed no bedding planes, but they were developed by retorting. Plant structure was clearly noted in a number of the pieces which indicated its derivation, and when freshly broken gave the faintest odor of petroleum at times.

EXPERIMENTAL METHOD

The first apparatus used for distilling the shale was a modification of that used by the United States Geological Survey. The permanent gases formed after being led through an ammonia scrubber were passed successively through a gas meter, a scrubber with 1.84 specific gravity sulphuric acid to remove unsaturated gases and another meter to record unabsorbed gases. The shale was broken up into pieces about three-fourths of an inch square, and a one-pound charge was introduced into the retort. The retort was slowly heated with a five Bunsen burner cluster until a dull-red heat was attained, and kept at this temperature for about four hours. The apparatus was then disconnected, the condensed liquids consisting of oil and water placed in a graduate and allowed to stand until a sharp line marked off the oil from the water and the quantity of each was then read off. The liquids were then placed in a separatory funnel, and allowed to stand for about twelve hours, a clean separation then being made. The water portion was added to the liquor (dilute sulphuric acid) from the ammonia scrubber and the ammonia determined by the Kjeldahl method. The oil was later subjected to a distillation analysis, and the various fractions further examined.

Further tests were made to determine solubility, ash, fixed carbon, and volatile matter.

The products resulting from the retorting of one pound of oil shale was not sufficient to make more than the following data in tables No. I and No. II:

TABLE I.

	Per Cent
Spent shale.....	84.1
Ash.....	61.3
Fixed carbon.....	22.8
Total volatile matter.....	38.7
Oil.....	7.49
Water.....	2.79
Soluble in CS_2	0.13
Ammonia as sulphate of ammonium.....	1.27

TABLE II.

Products Produced per Ton		
Oil.....	20.3	gal.
Total permanent gas.....	1,947	cu.ft.
Sulphate of ammonia.....	25.4	pounds

Since the retorting of one pound of oil shale did not give sufficient oil for close analytical results, a

larger charge was taken consisting of twelve pounds. For this purpose a horizontal retort was used of 8" diameter and length of 18" and made of double extra heavy lap welded steel tubing, which was built so as to conduct experiments later of retorting oil shale under vacuum and pressure, thereby varying the type product formed.

The method of retorting was by means of direct heating, with a thermometer inserted into a well in the body of the shale, and another thermometer in the vapor line of the retort. In table No. III, the still and the vapor-line temperature are shown. The last hour of retorting showed no liquid or vapors coming over, hence it was concluded that the oil had all been distilled out of the shale.

TABLE III.

First drop over water,
136°C. Vapor temperature
190°C. Still temperature

Time	Still Temperature, Deg. C.	Vapor Line Temperature, Deg. C.	
10:55 a.m.	20	20	
11:25 a.m.	103	78	
:55 a.m.	213	176	
12:25 p.m.	315	219	
:55 p.m.	358	266	
1:25 p.m.	365	278	Odor of ammonia
:55 p.m.	370	304	
2:25 p.m.	400	323	
:55 p.m.	(a)	348	Distinctly stronger odor of ammonia
3:25 p.m.	(a)	350	
:55 p.m.	(a)	355	Very strong odor of ammonia
4:25 p.m.	(a)	360	
:55 p.m.	(a)	370	

Total retorting time 6 hours.

(a) Above 400°C. Still, reddish, white heat.

During the retorting of the shale, distillates of oil and water were collected every 100 cc. and the endeavor was made to distill at the rate of 100 cc. per hour. The gravity of the oil portion was taken, and the curious phenomenon was noted that the gravity of the oil in the first fraction was higher than the second and third and then the gravity increased again. The data indicates two maxima and a minimum in the values of the gravity of the various cuts. This is unusual, for the specific gravity of an oil upon distillation increases with increase of the boiling point. This phenomenon requires further investigation as it is certain that we have to deal with a different group of compounds from what is ordinarily known. This may be due to heterocyclic nitrogen compounds. Furthermore, during the retorting of the shale, droplets of liquid falling from the end of the condenser at times were insoluble in the oil layer and passed through the water layer to the bottom of the receiver. This was clear proof that we had to deal with oily material having specific gravity greater than water. There was only a trace of this material in comparison to the whole and not sufficient to test for; hence, to investigate this point a ton or more of shale would have to be retorted.

It was further noted that as the retorting proceeded the ammonia content of the water layer of the distilla-

tion cuts increased, which indicated that the yield of ammonia increases with temperature to a maximum, and then more than likely decreases.

The data is expressed in table No. IV.

TABLE IV. PRODUCTS OVER FROM RETORTING

Sample	Total c.c. Over Oil and Water	c.c. Oil Over	c.c. Water Over	Specific Gravity of Oil 15.5°C.	Beaumé Gravity of Oil 60°F.
1	100	41.0	59.0	0.837	37.3
2	200	63.0	37.0	0.826	39.5
3	300	73.5	26.5	0.814	41.9
4	400	87.0	13.0	0.887	27.8
5	500	89.0	11.0	0.911	23.8
6	600	83.0	17.0	0.944	18.4
7	676	69.0	7.0	0.961	15.7
Total c.c.	676	505.5	170.5	0.879	29.3

Tests on Composite Samples of Recovered Oil

Beaumé gravity.....	29.3	Specific gravity 0.879
Flash point below.....	95°F.	
Viscosity Saybolt Universal.....	100°F., 32.8	
Color.....	6	
Cold test.....	-18°F.	

DISTILLATION ANALYSIS OF RECOVERED OIL

The color of the recovered oil was a dark brownish red. Upon distillation, the analytical data is given in table No. V, the first 10 per cent of which showed a strong lemon color increasing in intensity until 40 per cent came over. The color of the distillates became darker, merging into wine red, with a black solid residuum in the flask, which showed a tendency toward cracking at a temperature of 360° C. The phenomenon of a liquid coming over during retorting which was partially insoluble in the shale oil and heavier than water has already been referred to. The same type reddish liquid came over in traces upon distilling the recovered oil which was insoluble in the lemon-colored distillate and fell to the bottom of the receiver. What type compound or compounds this represented, as to whether it was a nitrogen or sulphur compound with a low boiling point and high specific gravity, has not been ascertained as yet.

Table No. VI is the distillation data of the crude benzene cut of the recovered oil which was taken as the first 50 per cent over at a temperature of 435° F. and averaged Beaumé Gravity of 42.9.

In analyzing the data to arrive at a commercial motor fuel having an end point distillation of a present value of 410° F. and 57-58° Beaumé, we find that 85 per cent gives an end point of 405° F. but a Beaumé gravity of 45.9°. Although the volatility of the mixture will pass for a motor fuel, the gravity is very low; furthermore, the 85 per cent contains 36 per cent of substances combining with 1.84 sulphuric acid. Upon neutralizing the excess sulphuric acid with 6° Beaumé caustic soda and washing with water and drying over calcium chloride, a deep reddish black oil remained which would be the so-called motor fuel. For upon redistillation of the refined reddish black "gasoline cut", seventy per cent of distillate was a deep lemon color which upon standing developed a deep reddish-brown color with a Beaumé gravity of 47.3 which corresponds to a heavy naptha in petroleum technology. Much technical work will have to be carried on to refine the crude benzene from oil shale retorting so as to make a marketable motor fuel for internal combustion engines as at present constructed. To work up this oil into a marketable motor fuel is a much more difficult problem than the simple one now presented to the petroleum industry, due to the fact that this oil undoubtedly contains sul-

phur, nitrogen, highly unsaturated hydrocarbons of the terpene type, aromatic and phenolic compounds.

The higher boiling point cuts show beautiful lubricating oils of similar properties to those obtained from California and Russian oils. The oils must be highly naphthenic in character, and this point will be reported upon more fully in a later paper.

TABLE V. DISTILLATION ANALYSIS OF RECOVERED OIL

Specific gravity.....	15.5°C.	0.8786
Beaumé gravity.....	60°F.	29.3
Per cent unsaturates.....		31.0
First drop over.....	55°C.	131°F.
Rate distillation.....	5 c.c. per minute	Engler Flask

Per cent Distilled Over	Degrees Cent.	Specific Gravity	Degrees Fahr.	Beaumé Gravity Bureau of Standard
5	116	0.7365	240	60.1
10	124	0.7411	254	58.9
15	131	0.7621	268	53.7
20	148	0.7839	300	48.6
25	159	0.7982	320	45.4
30	165	0.8092	331	43.0
35	184	0.8226	364	40.2
40	198	0.8358	390	37.5
45	209	0.8469	410	35.3
50	223	0.8584	435	33.1
55	234	0.8701	454	30.9
60	251	0.8822	486	28.7
65	265	0.8951	511	26.4
70	278	0.9091	534	24.0
75	303	0.9244	579	20.8
80	332	0.9472	630	17.8
85	357	0.9635	675	15.3
90	360	0.9804	681	12.8
8.5 residuum...		Solid		Solid

Distillation loss 1.5 percent.

TABLE VI. REDISTILLATION OF MOTOR FUEL CUT OF RECOVERED OIL

Specific gravity.....	15.5°C.	0.8097
Beaumé gravity.....	60°F.	42.9
First drop over.....	146°F.	63.5°C.
End point.....	501°F.	207°C.
Distillation range.....	355°F.	178.5°C.

Per Cent Distilled Over	Degrees Cent.	Degrees Fahr.	Specific Gravity	Beaumé Gravity Bureau of Standard	Per Cent Unsaturation
5	79	209			
10	87	227			
15	93	241	0.7527	56.1	36
20	99	254			
25	103	264			
30	107	275			
35	112	286			
40	116	295	0.7923	46.7	33
45	121	306			
50	125	315			
55	130	325			
60	135	338			
65	140	349	0.8235	40.0	30
70	145	359			
75	152	376			
80	158	388			
85	165	405	0.8584	33.1	40
90	175	427			
95	193	467			
End point	207	501			
Per cent Loss	2.5				

UNSATURATED HYDROCARBONS

In the cracking of hydrocarbon material in general the four types predominant are:

1. Paraffins.
2. Unsaturated compounds as acetylenes, olefins, and terpenes.
3. Naphthenes.
4. Aromatics.

Since it is generally held that the heat treatment of oil shale is a cracking phenomena, then the type of compounds formed under thermal treatment is a function of the temperature under which retorting takes place. Since this is so then the percentage of unsaturated hydrocarbons in the distillates must be dependent upon the percentage of carbon and hydrogen in the oil shale under treatment at the particular stage of shale decomposition. But, the problem is greatly complicated by the presence of sulphur, nitrogen and oxygen present in the starting material as is witnessed by the

decreasing yield of water every 100 c.c. distillate over, and the increase of the ammonia yield with increase of temperature.

In table No. VII, the surprising result is shown of the percentage of unsaturates indicating two maxima, and one minimum value. A maximum of 32 per cent is shown in the first ten per cent cut decreasing to twenty-four per cent and then reaching a maximum value in the last cut. In all thermal¹ and pressure treatment of hydrocarbon material as petroleum oils the percentage yields of unsaturates increase from a minimum to a maximum and then a minimum value. There is a question as to whether the absorbed by 1.84 specific gravity acid method² registers only unsaturated hydrocarbons. From the amount of nitrogen and sulphur compound and water distilled over, we may well be dealing with some alkylamines, diamines, imines, amides, thioamides, anilides and nitriles, pyridine, pyrrol and quinoline bases.

TABLE VII. PER CENT OF UNSATURATES IN DISTILLATION CUTS FROM RECOVERED OIL

Per Cent Unsaturates in Recovered Oil, 31.0	
Distillation Cuts Per Cent	Per Cent Unsaturate in Cuts
0-10	32
10-20	26
20-30	24
30-40	26
40-50	30
50-60	36
60-70	40
70-80	50
80-90	Whole mass solid

A. H. Allen³ gave a series of values upon the reactive properties of olefins in shale and petroleum products. He assumed that the relative proportion of olefins present in two products of similar density and boiling points is fairly accurately indicated by the power of assimilating bromine. Hence, the following table No. VIII, would show the relative amounts of olefins present in shale and petroleum products:

TABLE VIII.

	Shale Products		Petroleum Products	
	Specific Gravity 15.5°C.	Per Cent Bromine in Product	Specific Gravity 15.5°C.	Per Cent Bromine in Product
Gasoline.....	0.665	41.6	0.652	4.8
Naphtha.....	0.718	48.7	0.690	8.8
Burning oil.....	0.801	27.9	0.800	14.7
Burning oil.....	0.806	26.7	.....	.....
Lubricating oil.....	0.875	31.2	0.862	17.7
Lubricating oil.....	0.889	36.0	0.905	24.1

Although Allen does not give details as to the method of production, conditions under which olefins formed, and sources of his shale and petroleum products, the data are interesting in qualitatively verifying the data in table No. VII. The shale oil products, as the specific gravity increases, shows a decrease in unsaturates and then an increase similar in nature to those found by the writers. However, it is certain that petroleum products are not complexed to the same extent by various nitrogen, oxygen and sulphur compounds as are the oil shale products.

AROMATIC HYDROCARBONS

The formation of aromatic hydrocarbons during the decomposition of the bituminous material present in the shale was suspected, hence a test was made for benzene, toluene, xylenes, naphthalene and anthracene. The oil was fractionated by means of a Hempel

Column several times, and the cut between 78° and 82° C. analyzed for benzene by using a 2:1 concentrated sulphuric-fuming nitric acid mixture, and heating so as to form dinitrobenzenes. The dinitrobenzenes were treated with alcohol and 1-3 dinitrobenzene crystallized out with a melting point of 89.7° C. Toluene was tested for in the distillation cut from 107°-113° C., by treating with a concentrated nitric sulphuric acid mixture according to the Langenscheidt method.⁴ The TNT formed was recrystallized from alcohol and gave a melting point of 80.2° C. The xylene cut of 137-142° C. was nitrated in a similar manner, but care was taken so as not to form benzoic or phthalic acid from the oxidation of the side chains. The 2-4-6 trinitro-xylene was isolated by crystallization and identified by its melting point of 181.5° C.

The tests for naphthalene and anthracene were subject to great difficulties due to the large amount of solid paraffin present and their separation was not successful. However, it is unlikely that more than a trace of these two hydrocarbons could have been present due to the relatively low temperature of retorting the shale. The formation of naphthalene and anthracene are relatively high temperature reaction products.⁵ But, it is certain that naphthalene and anthracene would form at higher temperatures in the destructive distillation of oil shale.

The percentage of aromatic hydrocarbon formation of benzene, toluene and xylene under the conditions of these experiments was small, but, the recovered oil could be retorted again in gas machines and give commercial yields of these products.

ANALYSIS OF WATER RESULTING FROM THE THERMAL DECOMPOSITION OF THE OIL SHALE

The water distillate was an amber-colored liquid with a strong odor of ammonia and heterocyclic nitrogen compounds like pyrrol, pyridine and similar substances. The percentage of this water distillate upon the total liquid recovered was 25.2 and upon a weight basis of a ton of shale, 3.0 per cent. The oil and water distillate as the retorting progressed, was collected in 100-c.c. samples. The following table No. IX, gives the per cent of water in the 100 c.c. fractions of oil and water distillates.

TABLE IX.

100 c.c. Samples	Per Cent of Water
1	59.0
2	37.0
3	26.5
4	13.0
5	11.0
6	17.0
7 (Basis 100 c.c.)	9.2

Upon analysis a composite sample of the water distillate gave the following data in table No. X.

TABLE X.

Specific gravity.....	1.022
H ₂ S per cent.....	0.179
CO ₂ per cent.....	Trace
NH ₃ per cent.....	1.580
Ether extraction per cent.....	nil (practically)
CS ₂ extraction per cent.....	0.0025
Reaction to litmus.....	alkaline (strongly)

In the extraction by carbon bisulphide a wax-like solid was separated which had a pungent odor of heterocyclic nitrogen compounds, stronger than the original water solution. No further work was possible

¹Egloff and Twomey, Met. and Chem. Eng. 14, 1916.

²Ibid.

³Analyst 6, 177, 1881.

⁴Z. Ges. Schless-Sprengstoff 7, 425.

⁵Egloff and Twomey, Jour. Phys. Chem. 20, 121, 1916.

on this waxy solid due to the small amount obtained. To investigate this point would require the retorting of at least one ton of oil shale.

PHENOLS

The formation of phenolic compounds due to retorting oil shale is to be expected, when one considers the amount of oxygen in the starting material, and the percentage of water and oil distillate given off. But, the yield seems to be much smaller than one would be led to expect. Thomas Gray* in 1902 treated 3,200 gallons of "green naphtha" obtained from Scotch shale with 28 gallons of (27 per cent) sodium hydroxide solution. The aqueous solution was separated and the phenolic compounds precipitated out of solution with an excess of sulphuric acid which yielded approximately one and one-half gallons of crude phenols called "creosote oil" or 0.047 per cent of the "green naphtha" started with. During the distillation of a portion of this brown oily liquid the odor of sulphur dioxide, and hydrogen sulphide was noted.

Four hundred grams of "creosote oil" upon distillation gave the following results in table No. XI.

TABLE XI. CREOSOTE OIL

Temperature	Sixth Grams	Distillation Per Cent
Below 195°C.	47.8	11.95
195 to 200	42.4	10.60
200 to 205	49.4	12.35
205 to 210	46.2	11.55
210 to 215	36.4	9.13
215 to 220	22.7	5.68
220 to 230	21.6	5.40
230 to 235	3.7	0.93

The first distillation residue above 230° C. was pitch-like in character and was 16 per cent of the creosote. After thirteen distillations phenol was found to be present in a small amount. The (o) and (m) cresols were separated but no (p). The 1, 2, 4 and 1, 3, 5 xylenols were identified and a very small quantity of guaiacol. In table No. XII is given the approximate percentages of the phenols, as calculated from the data of Gray.

TABLE XII.

Phenols from 3,200 gallons "Green Naphtha"
1.5 Gallons Creosote Oil from 3,200 Gallons "Green Naphtha"

	Per Cent in 1.5 Gallons Creosote Oil	Gallons	Per Cent on Basis of 3,200 Gallons "Green Naphtha" Started With
Phenol	5-6	0.0825	0.0025
(o) Cresol	12-15	0.2025	0.0063
(m) Cresol	15-17.5	0.2438	0.0076
Xylenols	15-17.5	0.2438	0.0076
Guaiacol	Very small		
Phenols—B. P. above 230°C. .	16.0	0.2400	0.0075

The percentage of phenolic compounds has been calculated on the basis of the 3,200 gallons of "green naphtha" started with, by taking the mean of the values recorded by Gray. These percentage yields indicate the slight phenolic compound formation due to the thermal decomposition of oil shale, when one considers that several hundred tons of oil shale are required to form 3,200 gallons of "green naphtha." Despite this large amount of oil shale retorted, Gray stated that to separate the phenolic compounds formed, even a larger quantity of "green naphtha" would be necessary; hence, probably, 1,000 or more tons of oil shale retorted would be necessary to determine the various phenols present. It has been stated that American oil shale will produce greater quantities of phenolic

compounds than the Scottish. This may be so, but as far as the writers are aware no experimental data has appeared.

In the present work a careful analysis was made of the recovered oil for phenolic compounds, but the sample obtained from the retorting of shale was much too small for anything more than a mere qualitative test. As the above work by Gray indicates, a very large amount of oil would have to be treated to isolate the phenolic compounds present.

A 50-c.c. sample of the cut between 170°-190° C. of the recovered shale oil was treated, with a 20 per cent sodium hydroxide solution, and then neutralized with sulphuric acid. The solution was filtered and distilled, a strong odor of phenol being noted at the end of the condenser. Part of the distillate was treated with bromine water, and a very small slightly yellowish precipitate of 2, 4, 6 tribromphenol was indicated. The distillate was also treated with ferric chloride which gave a violet coloration in the solution which is a characteristic test for phenol, but it must be remembered that other phenolic compounds give violet colored solutions upon treatment with ferric chloride. The phenol present was no more than a trace. A further search was made to isolate other phenolic compounds of the di-tri and tetra hydroxy benzene and hydroxytoluene, xylene and mesitylene, but without success with the amount of oil at hand. A piece of research of the highest importance in connection with American oil shale retorting is to determine the commercial yields of not alone the phenolic compounds of the above type, but also as to whether thymol and carvacrol are formed, and furthermore, phenol—alcohol—ethers must also be produced of the type of anisole, phenetole and phenol ether, as diphenyl oxide.

THIO-DERIVATIVES OF PHENOL

Due to the fact, that the water distillate resulting from the thermal treatment of the oil shale under discussion gave 0.179 per cent of hydrogen sulphide, the writers endeavored to isolate and identify thiofen, mercaptans of the paraffin and aromatic types. That thiophenol, phenyl sulphide, thioanisole, thiophenetole and similar compounds are formed is reasonably certain, for their formation is along similar lines to the oxygen alcohols, ethers of the paraffin and aromatic series. In this communication the only sulphur compound isolated and identified with certainty was hydrogen sulphide, and further work along this line awaits the retorting of a very large quantity of shale, as also for the further identification of phenolic compounds in shale oil.

HETEROCYCLIC NITROGEN COMPOUNDS

The researches of Anderson,¹ Hofman² and Stenhouse³ have indicated that when nitrogenous material of organic derivation is subjected to destructive distillation some of the products formed are ammonia and volatile organic bases. It would then be expected that bituminous material like oil shale containing nitrogen would likewise produce heterocyclic nitrogen compounds of the pyrrol, pyridine, quinolint and acridine series, similar

¹Edinburgh Phil. Trans. XX 2, 247. Jour. Chem. Soc. 4, 112, 1852.

²Jour. Chem. Soc. 4, 304, 1852. Ibid 3, 279, 1851.

³Jour. Chem. Soc. 3, 309, 1851.

*Soc. Chem. Ind. Jour. 21, 845, 1902.

to the destructive distillation of wood, bone, coal and the varied nitrogen containing organic material.

Williams,¹⁰ working upon a crude naphtha resulting from the retorting of a Dorsetshire shale rich in fossilized animal remains isolated a number of heterocyclic nitrogen compounds of the pyrrol and pyridine series. He treated crude naphtha with sulphuric acid to extract the bases. The tarry matter was separated by boiling with water, during which pyrrol was evolved, and tested for by means of fir wood moistened with hydrogen iodide which turned to an intense purplish red. The sulphuric acid was then neutralized with potassium hydroxide and subjected to distillation. A nonbasic oil was separated by saturating the distillation product with hydrogen iodide, and the liquid again neutralized, and distilled. The ammonia was collected by passing through a strong solution of potassium hydroxide in which the bases were insoluble. The water present was taken up and removed by sticks of sodium hydroxide. The liquid was refractionated many, many times and fractions collected every 10° F.

The bases obtained were limpid, colorless and highly refractive. A persistent odor was noted which was pungent. The fractions burned with a smoky flame and fumed strongly in the presence of hydrogen iodide. The bases dissolved in hydrogen iodide with an evolution of heat and formed deliquescent salts. They dissolved readily in alcohol or ether. Upon the addition of cupric nitrate a complex precipitate like $(\text{CuNH}_3)_2$ was formed which dissolved in excess. The bases with boiling points below 320° F. dissolve readily in water, but above this temperature to a lesser extent. Those with boiling points below 320°—10° F. gave a beautiful green coloration upon treatment with bleaching powder.

The volatile bases were analyzed by means of precipitation with PtI_2 (author states PtI_3) and crystallization of platinum salts of these bases which is a much more reliable method than distillation. The following heterocyclic nitrogen compounds were isolated and identified from a crude naphtha resulting from the retorting of oil shale.

Pyrrol	$\text{C}_4\text{H}_7\text{N}$
Pyridine	$\text{C}_5\text{H}_7\text{N}$ (Formula?)
Picoline (methyl pyridine)	$\text{C}_6\text{H}_7\text{N}$ (Formula?)
Lutidine (dimethyl pyridine)	$\text{C}_7\text{H}_9\text{N}$ (Formula?)
New base (?)	$\text{C}_{10}\text{H}_{11}\text{N}$ (Formula?)
Parvoline	$\text{C}_{12}\text{H}_{13}\text{N}$ (Formula?)

Beilby¹¹ believes that animal vegetable matter tends toward the formation of carbonaceous material with the original nitrogen being retained. He states that all oils reacting from the destructive distillation of carbonaceous material containing nitrogen, more or less altered older organic remains, behave much the same as the original substance would have done. Albumen and gelatin and corresponding vegetable matter yield on thermal distillation:

1. Ammonia.
2. Oil rich in alkaloidal bodies.
3. Carbonaceous residue containing large proportions of original nitrogen.

When more or less altered deposits of peat, coal, shale, etc., are distilled a similar redistribution of the

nitrogen takes place. A distribution of the nitrogen in shale is shown after distillation in table No. 13.

TABLE XIII.

	Per Cent Nitrogen
Ammonia in water distillate	17.0
Oil as alkaloidal tars	20.4
Coke residue	62.6

He argues that the nitrogen of the shale started with upon retorting redistributes itself with a higher percentage in the higher boiling point fractions and reaches a maximum in the residue. The alkaloidal tars studied by him were approximately one-fourth by weight of the oil distillate. In the particular distillate studied the oil portion contained 1.16 per cent nitrogen while the alkaloidal tar contained 4 per cent. Upon redistillation of the tar and making ten fractions, the distribution of the nitrogen was, as is shown in table No. 14, although some of volatile alkaloids were lost.

TABLE XIV.

Fraction	Per Cent Nitrogen
1	Lost
2	3.54
3	3.37
4	3.35
5	3.24
6	3.47
7	3.54
8	3.35
9	3.54
Residue	4.00

The latter fractions were subjected to a red heat which indicates the relative stability of the nitrogen compounds. The formation of ammonia from reforming shale is a function of the conditions of temperature, time, retort and other factors, and that when heating is conducted slowly a decomposition of the alkaloids takes place producing more ammonia. The shale referred to above was then distilled very slowly and gave the following results in table No. 15.

TABLE XV.

	Per Cent Nitrogen
Total nitrogen	0.70
As ammonia in water distillate	0.23
As alkaloids in oil	0.14
In coke	0.32
Loss	0.01
Calculating on Basis of Total Nitrogen as 100	
As ammonia in water distillate	32.8
Alkaloids in oil	20.0
In coke	45.7
Loss	1.5

The latter experiment shows clearly the time factor in the increasing of the yield of ammonia at the expense of the alkaloids present in the residue coke.

Beilby made a series of nitrogen determinations of various pills, ozokerite, residuums and coke from Scotch shale, American residuum and coke and Galician ozokerite, the results of which are shown in table No. 16.

TABLE XVI.

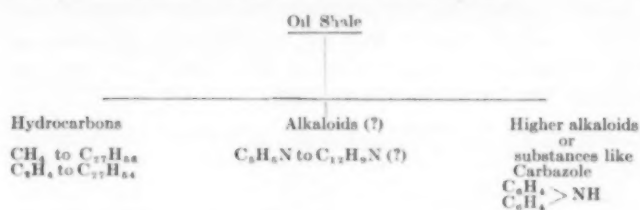
	Per Cent of Nitrogen
Scotch shale oil from retorts	1.160
Scotch petroleum or ozokerite	2.296
American petroleum residuum	0.080
Galician ozokerite	0.188
Scotch basic tar	3.900
American residuum tar	0.710
Scotch crude still coke	3.200
American crude still coke	0.375

The work of Beilby indicates that the nitrogen present in the original bituminous material increases in the latter fractions during retorting, reaching a maximum in the residue; furthermore, that during distillation of the shale only the more volatile alkaloids come off and the residue still contains the less volatile or pitchy nitrogenous bodies, and that it is probable that there are series of unbroken continuity from the volatile

¹⁰Chem. Soc. Jour. 7, 97, 1854. Philo. Mag. 4th ser. vol. 8, 209, 1854.

¹¹Soc. Chem. Ind. Jour. 3, 216, 1884.

pyridine, picoline up to pitchy or coke-like substances. Diagrammatically this is shown as follows:



In the present work the heterocyclic nitrogen compounds were not isolated due to the amount of distillate oil and water recovered not being sufficient for a close analysis. Attempts were made to isolate the volatile bases by means of precipitation and crystallization of the hydrochlorides, sulphates and platinichlorides, but too many complexes were formed which we were unable to separate—due to not being able to fractionate the starting material into close boiling fractions. However, that pyridine and its homologs are present is certain, for their characteristically pungent odor was noted clearly. The further study of these heterocyclic nitrogen compounds will be carried on, when sufficient starting material is obtainable. Due to the close analogy of the thermol decomposition products of bituminous material containing nitrogen, oxygen and sulphur, as coal, bone, wood and shale, similar volatile base type products have been isolated. It is suggested that when shale oil is thoroughly investigated, compounds of the furfurane, thiophene, pentamethylme oxide and penthiofene series will be isolated. They are so closely interwoven, synthesized and analogous in their behavior to some extent to the benzenes, phenols and one another as the formation of dimethyl furfurane, thiophene and pyrrol from acetonyl acetone, shows that similar synthesizing must occur when oil shale is subjected to thermal treatment.

PRODUCTS RECOVERED ON BASIS TON OIL SHALE RETORTED

In table No. 17, the results from retorting twelve pounds of oil shale are tabulated, with percentage yields of various products. Furthermore, the products based upon a ton of oil shale compare fairly closely with the results obtained by retorting one pound of the same shale. This particular oil shale from Colorado would average between twenty and twenty-one gallons of oil per ton and approximately twenty-five pounds of ammonium sulphate.

TABLE XVII. PER CENT PRODUCTS FROM OIL SHALE

Oil Shale	Pounds	Kilograms	Per Cent
Charge used	12.00	5.87	
Spent shale	10.00	4.89	83.3
Oil recovered	0.91	0.45	7.6
Water recovered	0.35	0.17	3.0
Ammonia	0.04	0.21	0.3
Gas and loss	0.61	0.34	5.8

Products per Ton Oil Shale Retorted		
Oil	20.7 gal.	
Total permanent gas	1,920 cu.ft.	
Sulphate of ammonia	23.3 lb.	

The following list of compounds have been isolated by various workers in oil shale retorting. They are fairly well diversified, but with further research in all likelihood there will be approximately as many different compounds identified as there have been from coal tar. Shale oil is an exceedingly complex mixture of hydrocarbon, oxygen, sulphur and nitrogen compounds

of complex structure, which would require the highest technical skill to separate for industrial use.

COMPOUNDS ISOLATED FROM OIL SHALE RETORTING

Carbon monoxide	(a)	Chrysene	(c)
Carbon dioxide	(a)	Pyrene	(c)
Hydrogen	(a)	Phenol	(d)
Methane	(a)	(o) (m) cresol	(d)
Ethylene	(a)	Xylenols	(d)
Oxygen	(a)	Guaiacol	(d)
Nitrogen	(a)	Pyrrol	(e)
Ammonia	(a)	Pyridine	(e)
Hydrogen sulfide	(a)	Picoline	(e)
Benzene	(b)	Lutidine	(e)
Toluene	(b)	Parvoline	(e)
Xylene	(b)	Quinolins	(e)

(a) Roman J. Soc. Chem. Ind. 10, 436, 1891.

(b) Present research.

(c) Bacon and Hamor American Petroleum Industry.

(d) Gray, Chem. Soc. Jour. 21, 845, 1902.

(e) Williams, Soc. Jour. 7, 97, 1854.

GENERAL SUMMARY

1. The derivation of oil shale is in all probability of the same origin as petroleum oil. The formation of bituminous shales is mainly due to slow evaporation of the impregnated oil, vegetable and animal matter in clays before or after being consolidated into shale.

2. The per cent of unsaturates in the distillation cuts of the shale oil showed the unusual phenomenon of two maxima and one minimum. In the first 10 per cent cut the percentage of unsaturates was 32, decreasing to 24 in the 20 to 30 per cent cut, increasing then to 50 per cent unsaturates in the 80 to 90 per cent cut.

3. Benzol, toluel and xylol were present in small amounts in the shale oil recovered.

4. The following phenols have been isolated from shale oil: phenol, (c) (m) cresol, xylenols and guaiacol.

5. Pyrrol, pyridine, picoline, lutidine and parvoline have been found in shale oil.

6. Scotland in 1916 produced 600,000 gallons or 14,260 barrels of gasoline or 0.7 per cent on the total oil recovered from the retorting of 3,500,000 tons of shale. The amount of gasoline produced in the United States in 1916 was 2,500,000,000 gallons. Scotland's production calculates 0.00024 per cent of this amount. The United States exported 110,000,000 gallons of gasoline to the United Kingdom of England in 1917.

7. The oil-shale industry of France is declining, and from government reports France is practically dependent for her oil supplies upon foreign countries.

8. In New South Wales the industry has declined for a number of years, and is at the present time more or less at a standstill. The tons of oil shale retorted dropped from 59,426 in 1895 to 17,425 in 1916.

9. The following tabulation covers the gallons of oil yield per ton of shale retorted in various countries and localities of the United States:

Shale From	Gallons Oil Per Ton	Pounds Ammonium Sulfate Per Ton	Average
Utah	25.0	13.3	38 samples
Wyoming	16.4	15.0	42 samples
Colorado	16.2	19.1	51 samples
Present Research (Colorado)	20.5	24.4	2 samples
Scotland	23.0	38.0	3,500,000 tons shale
Canada	34.9	51.3	44 samples
France	20.7	(a)	184,030 tons
New South Wales	(a)	(a)	17,425 tons
Black Shale:			
Pennsylvania	27.6	(a)	7 samples
Illinois	14.0	(a)	2 samples
Indiana	10.0	(a)	7 samples
Ohio	7.1	(a)	4 samples
Tennessee	5.2	(a)	13 samples
Kentucky	5.1	(a)	3 samples
W. Virginia	1.4	(a)	5 samples
Cannel Coal:			
Missouri	51.4	(a)	6 samples
Illinois	34.6	(a)	2 samples
Pennsylvania	29.6	17.2	5 samples

(a) Not determined.

In prospectuses, and a number of articles appearing in the oil journals of the country for calculating possible profits from oil shale retorting, the gallons of oil per ton of shale taken, range usually between 42 and 60. But, the above data indicate clearly that an average of shale retorting one-half these values would approximate the gallonage yield of oil per ton of shale retorted. The three states Utah, Wyoming and Colorado have been most carefully studied and the average of 133 samples collected approximate 20 gallons of oil per ton shale retorted.

10. It has been stated that there is sufficient shale in Colorado to produce twenty billion barrels of oil from which two billion barrels of gasoline may be extracted by the ordinary methods of refining. It is certain that no such amount of gasoline is obtainable from twenty billion barrels of oil resulting from retorting Colorado shale. Although nine samples distilled gave approximately 10 per cent of distillate with a volatility similar to gasoline, it is, however, not a gasoline suitable for internal-combustion engines. It is a distillate composed of paraffin hydrocarbons, unsaturated hydrocarbons, nitrogen compounds, sulphur and oxygen compounds. In fact, the complexity of the distillate due to the presence of alkaloidal bases, sulphur compounds and phenols, make it impractical to refine by the ordinary sulphuric acid-caustic soda method prevalent in ordinary refinery practice. Scotland has averaged less than one per cent of marketable gasoline from her shale retorting experience of over fifty years. Can we reasonably expect ten times as much gasoline from the retorting of Colorado shales, than Scotland does from her shales? The experimental evidence shows that the 10 per cent distillate of gasoline volatility from shale oil, will suffer a heavy loss upon refining to produce a marketable gasoline suitable for internal-combustion engines; furthermore, that nothing like 10 per cent or 2,000,000,000 barrels of gasoline will result from the refining of 20,000,000,000 barrels of shale oil from Colorado shale.

11. It is estimated that Southeastern Indiana is underlain with shale-bearing oil which contains 100,000,000,000 barrels of oil.

12. That oil shale is of the highest importance as a potential source of oil is certain. This has been recognized by our government in setting aside shale lands for the use of the navy. The ultimate commercial importance of a shale oil industry in the United States is taken for granted. That it will be an industry requiring very large capital in these days of large capitalization is also positive. At the present time no large shale retorting plants are in existence in the United States, and the cost of installing one is problematical. Furthermore, much experimentation will have to be carried on and the highest technical skill will be required to develop a shale-oil industry in the United States. That shale oil, even with ammonium sulphate as a byproduct can compete at the present time or in the near future with petroleum crude is questionable. For, it must be recognized that new oil fields are being discovered constantly and though many of the known fields of the United States are declining new ones are coming to the fore. Also, Mexico has a potential oil production of known fields of at least 300,000,-

000 barrels a year, and the oil fields of South America have not been tapped as yet. Yet the great oil shale deposits safeguard the economic life of the United States and makes it certain that we will be self-sustaining as to petroleum products during any period of our national life for at least a century.

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More Chromite Needed.—The Geological Survey has issued a statement in regard to the chromite situation showing that the present domestic output of chromite is scarcely one-fourth of the quantity needed for war and domestic uses, so that the other three-fourths must be imported. Hitherto most of our imported chromite has come from Rhodesia and New Caledonia, and, notwithstanding the scarcity of ships, much of it still comes from those distant lands. In response to our call for chromite Canada has rendered us most efficient help. In 1916 she sent us 10,930 long tons and in 1917 she more than doubled her shipments of chromite to the United States. The domestic production of chromite in 1916 was about 14,000 long tons, and last spring the prediction was made by Government geologists that in 1917 it would reach 48,000 long tons. According to J. S. Dillon, of the United States Geological Survey, the latest returns indicate that this prophecy has been fulfilled. Most of the known bodies of chromite are small, and those that lie far from lines of transportation are not available for exploitation by the ordinary miner because of the difficulty and expense of getting the ore to the market. Much of the chromite on the Pacific Coast is of low grade, averaging about 40 per cent of chromic oxide, and on that account is of less value than the imported ore, which generally contains 50 per cent or more of chromic oxide. Nicaragua is shipping a small quantity of ore to this country. At Antioquia, Colombia, chromite is reported to be so abundant that it has been used to build the walls of houses. Brazil has valuable deposits several hundred miles northwest of Bahia and may yet become a contributor to our needed supply. Most of the chromite we use is needed in factories in the eastern United States, and on account of the difficulty and expense of long transportation from the western deposits one of our most urgent present needs is to increase the production of chromite in the Atlantic States. The chrome industry of America really began in the eastern States. The mines of Maryland and Pennsylvania once supplied the world's chromite. A recent examination by the Geological Survey of the old chrome mines in Lancaster and Chester counties, Pa., suggests the possibility of successfully concentrating some of the bodies of spotted chrome ore in that region.

Alcohol is being synthesized in commercial quantities from acetylene at Visp, Wallis, Switzerland, according to reports, which are emphasized by the recent article, "Gnomes in Chemistry," *Vossische Zeitung*, by Prof. Dr. K. Arndt. Acetylene, formed by the reaction between calcium carbide and water, is hydrolized in the presence of certain mercury salts yielding acetaldehyde, which is readily reduced by hydrogen in presence of a catalyst (nickel) to alcohol.

Synopsis of Recent Metallurgical and Chemical Literature

Our Fuel Situation, by MR. WILLIAM M. BOOTH, was among the papers read at the meeting of the American Institute of Chemical Engineers at Gorham. Mr. Booth gave a brief account of the transition of the wood fuel days into the present coal age. His table of the British Thermal Units one dollar will buy was very instructive:

	B.t.u. @ \$1.00	
Bituminous coal.....	13,500 b.t.u. per lb.	6,750,000
	2,000 lb. @ \$4.00	
Anthracite.....	13,500 b.t.u. per lb.	3,375,000
	2,000 lb. @ \$8.00	
Seasoned hardwood.....	4,000 b.t.u. per lb.	2,700,000
	\$8.00 per 4-ft. cord	
Natural gas.....	1,000 b.t.u. per cu.ft.	3,333,000
	30c. per 1,000 ft.	
City gas.....	600 b.t.u. per cu.ft.	600,000
	\$1.00 per 1,000 ft.	
Crude oil.....	19,000 b.t.u. per lb.	1,615,000
	\$4.00 per bbl.	
Electricity.....	8c. per kw.-hr.	4,266
	1c. per kw.-hr.	34,128
Alcohol.....	95% vol.	78,302
	\$1 per gal. (6.58 lb.)	

WOOD FOR RURAL DISTRICTS—CENTRAL PLANTS FOR CITIES

Mr. Booth gave two tons as an average wood growth rate, per acre of land and thought that in the distant future, the farmer would grow his own fuel off of four or five acres of land. This would not be practical for the cities, for each family would need, on an average, 2000 cu.ft.—this transportation and storage space not being available. Much larger central gas plants will form the solution of the fuel problem in the cities, the overhead expenses of which will be proportionately less as they increase in capacity. Central heating plants can deliver steam for house heating purposes at a saving to the consumer not only of labor but of actual fuel costs in proportion as the plants grow larger, and better conducting pipe lines are provided.

COAL ECONOMY

Because of the comparative cheapness of coal in the past, manufacturers have heretofore never appreciated the future fuel tendencies—higher prices and poorer quality. With transportation and mining capacities unable to supply the present demands interest in the fuel economist is gradually growing. It is to be expected that in the future engineers will have large financial support in their work of attempting to improve the heat yields by the use of better designed equipment, and that preparations will now be forthcoming for the less-coal age. Peat, lignite and shale oil will eventually provide a fair source of material.

At the conclusion of the reading, discussion arose in regard to taking all the available water from Niagara Falls for certain periods of time for electric power generation. Those opposed to such drastic action thought that with the present prices of coal produced power, in all probability no financial gain commensurate with the æsthetic loss could be obtained. Upon a motion made by Mr. J. M. Weiss, it was finally decided to first obtain figure to show the exact relative fuel value of the falls to our coal consumption.

Manganese Steel Rails.—An account which the American Railway Engineering Association has published in Bulletin No. 199 by M. H. WICKHORST, gives the detailed circumstances of various track tests on manganese steel rails, and containing the following conclusions: Manganese steel rails abrade much slower than Bessemer or open-hearth rails on sharp curves, according to the following approximations for curves of 8 or 9 degrees: manganese 0.004 sq.in. per million tons of traffic; open-hearth, 0.012 sq.in.; Bessemer, 0.020 sq.in. The results vary considerably and are probably dependent on the nature of the rolling stock as well as the tonnage. Manganese steel rails become distorted by spreading and drooping of the head more easily than do the others, possibly due to the low elastic limit. Failures of early installations were extremely high, consisting mostly of transverse cracks in the head, but manufacturers claim to have perfected methods for producing a better quality in this respect. Very large deposits of pyrolusite are being developed in Brazil which will supply the demand should it become large.

Alcohol from Sulphite Waste Liquors.—Among the papers read at the June meeting of the American Institute of Chemical Engineers at Gorham, N. H., DR. RALPH H. MCKEE read a paper regarding the fermentation of the sugars in sulphite pulp waste liquor to alcohol without neutralizing the complex magnesia-lime organic acid-sulphite compounds—Dr. McKee having found that yeast lived and functioned normally in this liquor while a current of air was being blown through. While his work has been limited to the scope of the laboratory, he recommended that the hot liquor from the blow off of the digestors be sprayed in a tower countercurrent to an air current with cooling arrangements so that it would arrive at the fermenting vats at less than 90° F., below which temperature yeast thrives.

ADVANTAGES OF PROCESS

Upon fractional distillation, some sulphur dioxide is present in the alcohol obtained but is readily removed by soda ash. The advantages of this process are claimed to be:

1. Saving of equipment.
2. No neutralizing with lime.
3. Saving in manufacturing costs.

During the subsequent discussion of the paper, Mr. H. O. Chute confirmed the fact that yeast was materially aided by air blowing and added that some form of nitrogen and phosphorus had to be added. Mr. Hugh K. Moore asked if NH_4Cl with the CaSO_4 present would be beneficial. Dr. McKee affirmed this and added that old yeast, hydrolysed at 120° F., made good yeast food. In discussing the form of still adapted to fractionating such a dilute solution of alcohol, Mr. Chute said that a still with a very high tower fractionating column was essential. No data were given regarding the effect of the air in removing or oxidizing the sulphite acids during the passage through the cooling tower, and subsequent fermentation, nor concerning the tendency of the gas sweeping action of the air blowing to carry off the alcohol vapor as it is produced in the vats by the yeast fermentation.

Recent Metallurgical and Chemical Patents

Reclaiming System in a Sulphite Pulp Process.—C. B. THORNE, of Hawkesbury, Ontario, patents a reclaiming system in a milk-of-lime sulphite pulp process. It comprises a novel method of recovering digester vapors with the object of economical production of acid liquor. In Fig. 1, the digester 1 discharges into a separator 3, from whence the gas is drawn through cooler 5 to the base of the recovery tower 8. Here the gas rises against a downcoming

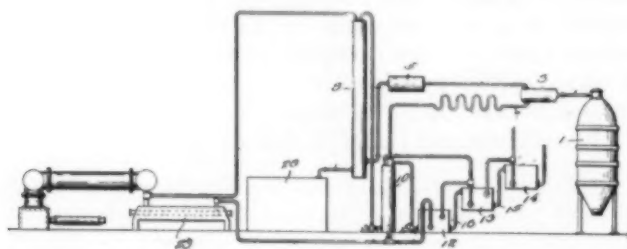


Fig. 1

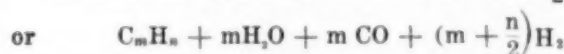
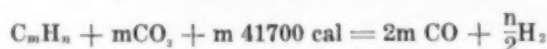
shower of richest acid on its way to the storage tank 28, and any of it which escapes absorption is piped to the sulphur plant 23 or to the bottom of the acid tower 10. This acid tower is filled with oak, stone or other resistant material, and down it trickles the liquor from separator 3 and the acid from tanks 12, 13 and 14. The latter are so arranged that the liquor will overflow from the uppermost to the lowermost one through those intermediate by means of pipes 15 and 16. To create a suction for drawing the gases into the acid tanks the latter are made air tight and connected to any suitable exhausting plant. (1,263,486; Apr. 23, 1918.)

Manufacture of Wrought Iron.—JAMES ASTON, of Pittsburgh, Pa., patents the process of bundling milling chips or turnings of highly refined ingot iron, produced by the Bessemer or open-hearth process, and heating the bundle to a welding heat by immersing it in a molten bath of silicate slag of similar composition to puddle cinder. The hot bundles or fagots containing slag in their interstices are then squeezed and rolled into blooms, billets or bars, exactly as in the older puddling process. (Assigned to A. M. Byers Co., 1,255,499; Feb. 5, 1918.)

FREDERICK T. SNYDER, of Oak Park, Ill., patents the process of teeming oxidized metal and retaining a pasty slag high in lime (53%) and iron oxide (25%) in the furnace. This slag, being at about 1600 deg. C. will readily heat the incoming mixer metal which is at about 1300 deg. C., the iron oxide will readily oxidize the silicon, and when this slag is removed at the end of about 40 minutes, the temperature still being relatively low, this thin basic slag will contain but 5 per cent of iron oxide while carrying most of the phosphorus of the pig. A fresh slag is then made of approximately 250 pounds of lime and 400 pounds of iron ore per ton of metal; it is melted electrically and rapidly removes the remaining carbon and phosphorus.

The metal is tapped in about an hour, leaving the slag in the furnace as before. The process is claimed to rapidly produce iron low in nitrogen at small expense in basic materials needed to neutralize the silicious arch drippings. (1,254,078; Jan. 22, 1918.)

Sponge Iron.—SIGURD WESTBERG and EMIL EDWIN, of Norway, note that the reduction of iron ore by CO, being accompanied by no large heat effect, is more desirable than that by hydrogen, which absorbs quantities of heat. A pure gas is desirable since its use will produce a pure iron at a low temperature, and on account of its ease of control. This gas is produced by mixing pulverized carbon, atomized petroleum, or other finely divided carbonaceous material with carbon dioxide and causing the mixture to pass through a flaming arc such as is used in nitrogen fixation processes. The induced reaction absorbs much electrical energy and the gas may enter the iron reduction chamber at temperatures up to 1000 or 1100 deg. C. The reactions may be expressed as follows:



Any mixture of CO and H₂ in the issuing gases may be had by feeding proper substances to the flame; thus pulverized carbon and CO₂ will give practically pure CO; CO₂ and petroleum (containing only about 13 per cent hydrogen) will give some hydrogen for reduction purposes, while richer hydrogen gases required for high temperature reduction of lean ores may be had by substituting water vapor for the CO₂. The diagram, Fig. 2, shows the cyclic use of the

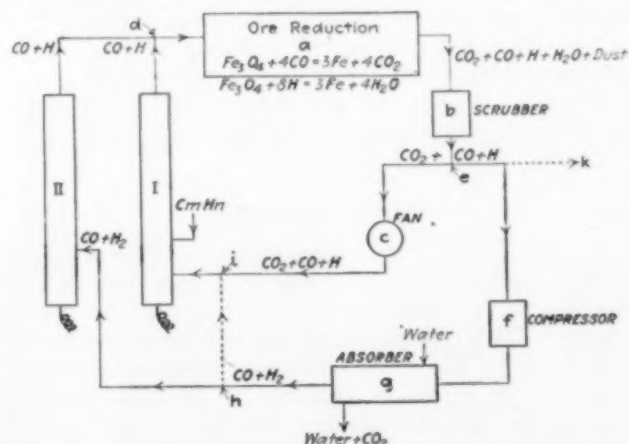


Fig. 2

gas scrubber b removing dust and water vapor, the dry gas being then blown by fan c through flame-furnace I. In order to maintain the proper balance between CO and H, part of the gas leaving the reduction chamber is bypassed through a CO₂ absorber and the CO₂-free portion heated in flame-furnace II, or used as combustible atmosphere in furnace I. Close regulation is had automatically in the latter system by dividing the gas from the scrubber about equally and the introduction of balanced gas-holders on each pipe line to give a constant pressure on the system. The regulation of the combustible only is then necessary. (1,256,623; Feb. 19, 1918.)

Manufacture of Phosphoric and Hydrofluosilicic Acids.—INGENUIN HECHENBLEICKNER, of Charlotte North Carolina, has already patented (1,167,775) improved apparatus for the electric furnace production of P_2O_5 , which delivers the dusty furnace gases to a rotary kiln wherein the phosphate rock and silica are preheated, and thence into a dust catcher where the bulk of the true dust is removed before the temperature has dropped low enough to precipitate the phosphorous pentoxide vapor. This, together with its

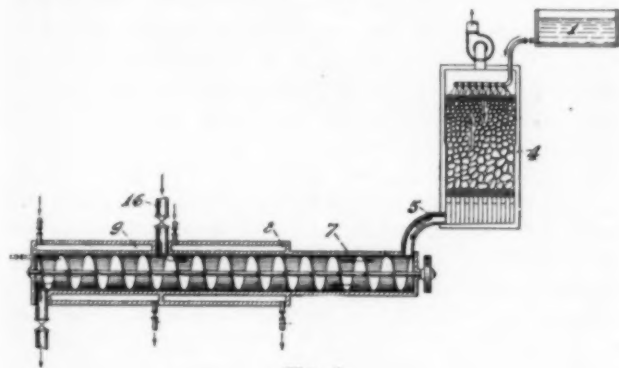


Fig. 3

usual content of silicon tetrafluoride, produced by the decomposition of the fluorite ordinarily present as an impurity in the charge, may be absorbed in water, forming a mixture of phosphoric acid (H_3PO_4) and hydrofluosilicic acid (H_2SiF_6) and which product when utilized in the manufacture of fertilizer may be employed without separation into its components. In case it is desirable to separate these acids, it may be done by cooling the dust-free gas to a point where the P_2O_5 condenses, and then removing this condensate in a Cottrell treater. The SiF_4 is carried on, to be absorbed in the ordinary counter current tower. (1,264,510.) The inventor also patents a variation of the furnace accessories, whereby a waste heat boiler is set close to the furnace, and which catches the true dust, cools the gases to about the condensation temperature of P_2O_5 , and produces steam power. In this case the furnace charge is introduced around the electrodes. (Assigned to the Southern Electro-Chemical Co., 1,264,510; Apr. 30, 1918.)

Deoxidizer of Titanium and Silicon.—NAPOLEON G. PETINOT, of New York City, (assigned to United States Alloys Corporation) notes that in the ordinary practice of deoxidation of steel baths with titanium, the oxides produced, being very infusible, remain entrapped in the solidifying metal. He has found that a mixture of silicon and titanium oxides containing 15 per cent of the former has a low melting point, and, therefore, if a deoxidizer containing five times as much titanium as silicon be added to oxidized steel baths, the resulting reaction will produce a fusible slag readily eliminated from the solidifying metal. (1,252,023; Jan. 1, 1918.) For manufacturing this alloy, he uses a proper mixture of pure ingredients such as rutile, quartz, charcoal and steel turnings. This is smelted in an electric furnace with a carbon bottom, and the end of the reduction of the thin layer of iron silicate slag temporarily formed is noted by the extreme instability of furnace operation, accom-

panied by the copious projection of molten metal from the bath. (1,260,037; Mar. 19, 1918.)

Concentration of Sludge Acid.—In the refining of petroleum, the oils are always treated with sulphuric acid, the acid and the withdrawn matters then settle out as a heavy sludge. This sludge is ordinarily treated with water, causing a separation into an oily layer called sludge oil, and an aqueous sulphuric acid containing many carbonaceous matters. WM. A. SLATER, of Fort Worth, Texas, finds that the concentration of this waste sludge acid for reuse may be effected by hot air. Instead of forming great volumes of sulphur dioxide by the reaction between the dissolved organic matters and the acid, as is usual when such acid is heated, there is separated granular carbon harmless in subsequent use, and very little oxide is liberated. The inventor attributes these results to "autoxidation" of the organic matters in the hot concentrating acid by the hot air; the sulphur dioxide which tends to form and the organic matter probably oxidizing simultaneously in the manner usual in autoxidations. Fig. 4 shows an arrangement suitable for performing the concentration—the pump 4 forces air through heating coils 1 placed in the flues of nearby stills, and delivers air at about 400 deg. F. to the concentrating tank 8, constructed tightly of acid proof material and having the necessary drains, manholes, thermometers and other auxiliaries. This hot air bubbles through the weak acid to be concentrated, and escapes from the tank, containing some atomized acid, by pipe 16, entering the bottom of the tower 17. Here it ascends against dripping weak acid circulated from tank 22. The air is further scrubbed in the water column 20, and finally escapes. The scrubbing water stored in tank 29 is used to dilute the sludge acid, which latter is the material circulated in tower 17, later to enter concentrator 8. Carbon separates from the acid in circulation through the aeration tower; separating in a rather peculiar form as brittle, round balls. This carbon settles at the bottom of tank 22 and is removed from time to time by cleaning. In

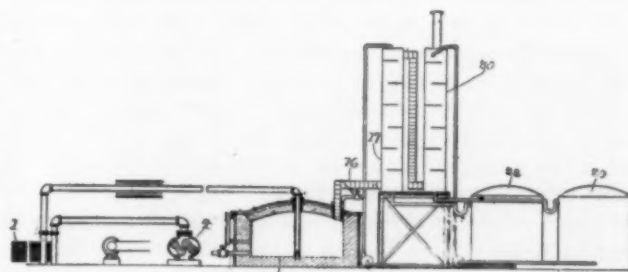


Fig. 4

normal operation the acid in tank 22 is at a temperature of about 200° F. The carbon forming in the concentrator is finely granular and is kept in suspension by the stirring action of the air, and is withdrawn with the concentrated acid. It is found that the temperature required to finish the acid up to 66 deg. Bé. varies somewhat, so that after the temperature reaches say 320 deg. F. it is tested from time to time and withdrawn when the necessary concentration is reached. (Assigned to Gulf Refining Co., 1,263,950; Apr. 23, 1918.)

A Modern Laboratory for Industrial Research

THE research and testing laboratory of Arthur D. Little, Inc. at Cambridge, Mass., is the fulfillment of plans laid long ago to make effective research easily available to American industry. It is but two and a half minutes' ride by subway from Park Street station in the heart of Boston, to Kendall Square, Cambridge; and from Kendall Square to the laboratory on the Charles River Road is but a four-minute walk. It is an ideal place for work, being at once quiet, sunny and pleasant. The building fronts on the Charles River Basin and beyond it on the further shore is the Back Bay District of Boston, while to the southwest there looms Beacon Hill, the golden dome of the Bulfinch State



LABORATORY IN MARCH, 1918

House and, if tradition is to be trusted, the Sacred Cod-fish. Along the river road to the west of the laboratory are the monumental buildings of the Massachusetts Institute of Technology.

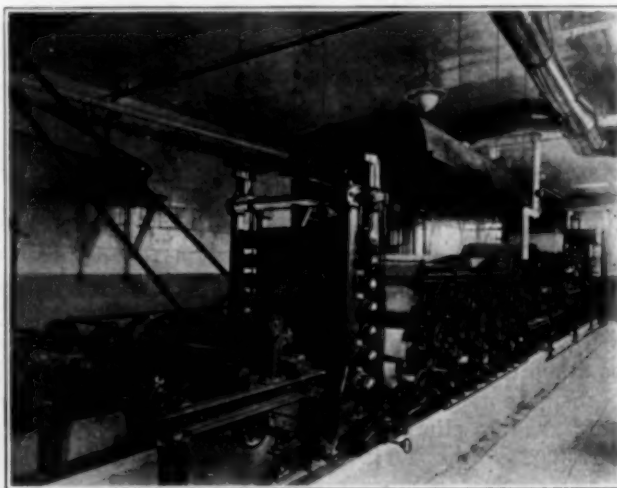
The first floor of the laboratory is devoted generally to the administrative and accounting department. It contains the offices of the president; the vice presidents, treasurer, secretary and service manager, the head of the commercial department, offices of several engineers, the drafting and accounting rooms and the museum. The museum is an interesting place. Its purpose is to show the relations of raw material to finished products over a wide range of industries. Types of cellulose and the long series of bodies made from it, a great variety of wood products, also a large number of minerals and their metallurgical products are displayed. We have not the space to describe it in detail, but shall content ourselves with saying that it is an enlightening experience for a business man to visit it. Even those with technical training find many surprises. Many maps are in preparation showing the known locations of materials all over the Western Hemisphere.

The second floor is devoted to research. Several of the laboratories are in full operation, while others are not yet completely equipped. Various details of the special equipments change from time to time, according to the nature of the problem in hand.

An interesting feature in regard to problems, as they come in, is that they seem to be addicted to fashions and styles. At present the preponderance of needs seems to be along the lines of applied colloidal chemistry.

On the second floor is a technical library which contains over 30,000 sources of information, indexed by means of over 100,000 cards. This part of the establishment holds the records of over 30 years in industrial research and a great mass of technical reports, bound in manuscript and indexed. It contains also in addition to the many books and sets of scientific periodicals, a large accumulation of clippings from all kinds of sources, filed in envelopes and indexed. The library occupies three rooms and bears a very favorable reputation among librarians because of its arrangement. It has been visited by the school for librarians at Albany, which is spoken of with favor by the guild; and in consulting practice it is found to be in constant use by members of the staff. A very well equipped textile laboratory is also on the second floor.

Analyses and tests are made on the third floor, excepting certain operations, which are carried out in the basement. The general analytical laboratory is at the eastern end of the building and is symmetrically arranged with double parallel rows of hoods made of alberene stone extending east and west on either side of the center. The northern end is devoted to metallurgical analyses, beginning with those of iron and steel. There is an electric furnace with five independent tubes for carbon determinations and a capacity of ten tests per hour. Determinations of copper, zinc, lead, nickel and cobalt are made by electrolysis. The rest of the laboratory is, properly speaking, of a general analytical nature and we shall only attempt to note some of the features observed in passing through. Extractions with water and high-boiling organic solvents are made here. Six oxygen tanks are in constant circulation. There are Freas drying ovens, a Freas incubator, a Hoskins electric furnace and much other highly special as well as general apparatus. Every hood has a gas hot-plate and a steam-bath with ten openings. At the end of each of the four rows of hoods is a section, which may be sealed for poisonous vapors. A water-still supplies the entire laboratory with distilled water through block tin pipes and silver faucets. Balance and volumetric rooms,



THE PAPER MILL

the latter equipped with daylight-lamps, connect with the general analytical laboratory. A separate laboratory with a calorimeter room containing an Emerson gold-lined calorimeter is provided for fuel testing. A

special room is equipped for extractions with inflammable solvents and for the recovery of the same. The optical room contains microscopes of various power and grade, a penetrometer for tars and asphalts, micrometers for determining the thickness of paper and other sheet materials, an ultra violet light apparatus of the same power and design as that used in the U. S. Bureau for Testing Materials, and about a hundred samples of paper of known composition with which com-



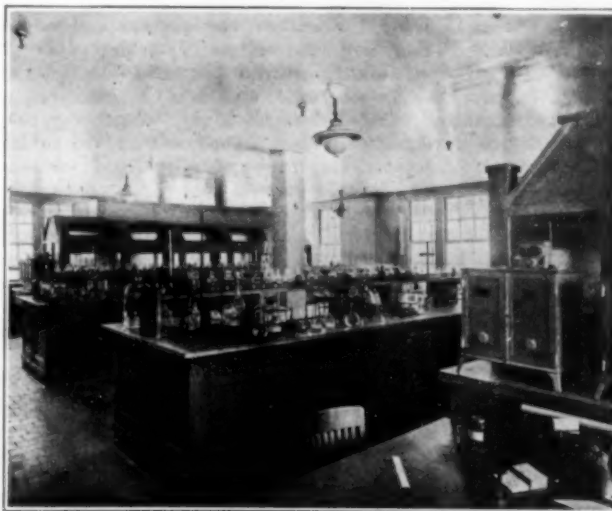
COMPLETE RECTIFYING STILL

parative fiber tests are made. For this purpose the samples are treated with the zinc chloride iodine stain, which colors ground wood pulp yellow, rag pulp red, and that of sulphite blue. Other fibers have their peculiar shapes and structural markings by which they are recognized under the microscope. Samples of fiber to be tested are checked against those of known content and the ratios are very closely approximated. Here and in the adjoining room for physical determination is a photomicrographic apparatus, a projectoscope, which is of great convenience for bringing the attention of several observers at once upon a problem, a polariscope, a Schopper paper tensile strength machine, a Schopper folder for measuring the resistance of paper to folding (two German instruments that should be made hereafter in America), Mullin strength testers which measure bursting strength in pound per square inch, Lloyd's hygrodisk (Taylor) that gives relative humidity to temperature for the control of tests, a privately designed apparatus for determining resistance of paper carton, etc., to bending, another original apparatus for determining the resistance of paper to tearing, a Perkins stretch tester and an Ives colorimeter.

The basement contains a room for crushing and grinding various substances. The mill for sampling coal is in a separate room, also in the basement. In another room is a rubber grinding machine; here are also located an emery wheel for polishing steel samples, a drill press for cutting them and a physical testing apparatus of 10,000 lb. capacity. The main stock room serves as a general store from which local stores of supplies on the second and third floors are furnished by means of a dumb-waiter. In the basement is a sample room, in which the original samples are kept for required periods. Another room (originally designed

for the convenience of the janitor) has been turned into a special research laboratory. Still another room is used for storing office files. The boiler room is in the rear. At the eastern end is a complete pulp and paper mill which is a small scale factory in itself. It contains a disc saw for slabs and chips, and two digesters, one rotary and one upright with respective capacities of 350 and 250 pounds of chips. The upright digester is lined with acid resisting brick and is equipped with valves, pressure gages and thermometers similar to those used in commercial practice. For sulphite acid liquors, there is a wooden tank with an agitator and pump. Attached to the digester is a lead-lined blow-off tank. There are two beaters for different kinds of paper stock, one a Jordan engine with a capacity of 100 pounds per hour, two stuff chests complete, and a combination Foudrinier and cylinder paper machine. The widest trimmed sheet which can be run through is 24 inches. The drying end of the machine contains 9 fifteen-inch driers with 32-inch face, and a calendar stack of 7 rolls of 7 inches diameter. Power is furnished by a 15-hp. motor for the beaters and the Jordan; a 5-hp. motor is attached to the constant speed end of the paper machine; while a 6-hp. variable speed motor provides power for the rest of it. One horsepower motors are used for agitators, pumps, etc. It really is a complete pulp and paper mill in which practically any kind of pulp or paper can be made.

At the western end of the basement is a considerable array of chemical apparatus for other work on a small factory scale. This includes tanks, vats, a diffusion battery, a luminous fractional tower and still and



GENERAL ANALYTICAL LABORATORY

other equipment. It is, like the paper mill, provided with an adjoining control laboratory.

A feature of great convenience is the relation of the general analytical to the research laboratories. Those engaged in research have their results tested and checked as often as they desire, which is naturally done far more expeditiously and accurately than if each research chemist had to rig up apparatus and make his own analyses. It was quite a venture to build this large establishment with such a great capacity, especially since it is a development to which industry has not as yet, in many respects, fully arrived.

Book Reviews

GENERAL CHEMISTRY. By *Hamilton P. Cady, Ph.D.* Octavo, (14 x 20 cm.), xiv + 522 pages, 73 illustrations; price, \$2.25. McGraw-Hill Book Company, Inc.: New York. Hill Publishing Co., Ltd.: London.

This is an elementary book, an abridgment and simplification of the author's earlier book entitled "Inorganic Chemistry," intended for a shorter course. There is a large amount of material in the book, very well arranged. Chemical facts are presented in large numbers before discussions of chemical theories are introduced as attempted explanations of the facts. The text is very reliable, and the industrial information scattered through it is particularly well chosen and up to date (with the exception of the manufacture of boron by Weintraub's method, and of sodium by Von Kugelgen's process). Here and there a generalization is made too broad or a dictum laid down too tight, which is really serious because it misinforms the student and blunts the development of his scientific acumen. Such a case is the statement (p. 6) that it is a law that "if two bodies agree exactly in some few of their essential properties they will agree exactly in all and are composed of the same substance"; another (p. 27), that "whenever two or more substances combine to form another substance, they do so in a perfectly fixed and invariable ratio by weight." When the author revises this excellent book, he should carefully excise these illogical statements and imperfect generalizations. Otherwise there is hardly anything but praise to be expressed for the clearness and accuracy of presentation and method shown on almost every page of the book.

* * *

VAN NOSTRAND'S CHEMICAL ANNUAL. By *John C. Olsen.* Fourth Issue, 778 pages. Price \$3.00. New York: D. Van Nostrand Company.

Since the 1913 issue the author has revised and added new material. The present volume has 161 tables of which 48 are new. The most authoritative chemical data on the physical constants of inorganic and organic compounds, alkaloids, essential oils, oils, fats, waxes, lubricating oils and gases are systematically treated. The standard tables of specific gravities of acids, bases, solutions and solvents are arranged in very legible form. The vapor tension of water and mercury, the equivalents of weights and measures, thermochemical data and the usual stoichiometrical and analytical data have highly satisfactory treatment. The special feature of this high grade book of tables is the chapter on stoichiometry by Prof. R. H. Ashley, in which a number of type problems are set and solved. These will be of great aid to many in becoming familiar with the application of the tables. A good catalog of technical books is included.

* * *

LABORATORY MANUAL OF BITUMINOUS MATERIALS. By *Prévost Hubbard.* Octavo (14 x 23 cm.), xi + 153 pages, 39 illustrations; price, \$1.50. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd.

Intended as a laboratory guide for students of highway engineering, this treatise not only develops the abstract technique of the laboratory, but also deals with the interpretation of the results of tests, such as the suitability of the materials for specific purposes and control of uniformity of the materials in question. The testing is limited to the bituminous materials used in highway construction, and does not extend to the other materials, such as stone, gravel, sand, filler, wood, etc. used with the bitumen. The scope of the work is therefore very limited but in its field it is most excellently and practically written. It is too advanced and too specialized for the ordinary civil engineering student, but will be of great value to the graduate student specializing in highway construction and for all road-building specialists. One sole criticism is the use of "burning point" in place of "ignition point."

THE CHEMIST'S POCKET MANUAL. By *Richard K. Meade.* 530 pages. Price \$3.50. Easton, Pa.: Chemical Publishing Company.

The manual is a very condensed book printed in small type, covering a very wide scope in a brief manner. A table of contents should have been included as it would prove of great aid in familiarizing the readers of the book with the material. The 180 pages of technical analysis will prove valuable to those who do not have access to larger works or want a resumé on this subject. The tables do not equal other recent publications in the pure chemical field but treat many subjects not ordinarily found in these, a small amount of applied physics being included.

Personal

MR. L. G. E. BIGNELL, formerly sales manager of the Denever office of Sutton, Steele & Steele, Inc., has been placed in charge of sales for the same company with offices in Dallas, Texas.

MR. G. GRUNBERG has recently severed his connection with the American Scientific Instrument Co. and has established his own business under the name of Scientific Utilities Company, Inc., which is located at 843 E. 10 St., N. Y. C.

DR. A. E. KENNELLY, acting head of the Department of Electrical Engineering at the Massachusetts of Technology, has been called to Washington for special work with the Signal Corps. He expects to return to the Institute in the fall.

MR. HENDERSON W. KNOTT, formerly general manager of the Morgan Crucible Company of New York City, has been appointed by the United States Fuel Administration to manage the field force of engineers and inspectors who are at work among the power plants of the country. He will carry out a campaign of instruction and inspection to bring the use of fuel for the production of power to the highest possible efficiency and economy.

DR. ARTHUR D. LITTLE, of Arthur D. Little, Inc., Cambridge, was conferred the honorary degree of Doctor of Chemistry by the University of Pittsburgh at the commencement exercises on May 31, 1918.

MR. A. NIEDERMEYER, for many years connected with the Worthington Pump and Machinery Corporation, more recently as Works Manager of the Snow-Holly Works of that corporation, at Buffalo, N. Y., resigned on May 31 to devote his entire time to enterprises of his own.

MR. DWIGHT P. ROBINSON and **MR. JOHN W. HALLOWELL** retired from the firm of Stone & Webster on July 1, and the business will be continued by the remaining partners **MESSRS. CHARLES A. STONE**, **EDWIN S. WEBSTER**, **RUSSELL ROBB**, and **HENRY G. BRADLEE**. Mr. Robinson has been with Stone & Webster since 1893, from 1908 as president of the Stone & Webster Engineering Corporation and a member of the firm since 1912. Mr. Hallowell has been with Stone & Webster since 1901 and a member of the firm since 1912. Since May 1917, he has been in Washington with Mr. Hoover as a member of the United States Food Administration and expects to continue in that work for the duration of the war.

MR. CHARLES B. SEEM has become actively connected with the Electric Furnace Company in the capacity of sales engineer. He was formerly with Perin & Marshall, Consulting Engineers.

DR. ALFRED STANSFIELD, Professor of Metallurgy of McGill University, was recently in San Francisco conferring with officials of the Noble Electric Company. Dr. Stansfield has been retained by the provincial government of British Columbia to report upon the possibilities of establishing an electric iron and steel industry in that region.

THE UNITED STATES FUEL ADMINISTRATION announces the appointment of administrative engineers as follows: **THOMAS R. BROWN**, Pittsburgh; for the western half of

Pennsylvania. He was formerly special engineer with the Westinghouse Air Brake Company. **GEORGE R. HENDERSON**, Philadelphia; for the eastern half of Pennsylvania. He was formerly consulting engineer with the Baldwin Locomotive Works. **EDWARD N. TRUMP**, New York; for the state of New York. He has been the vice president of the Solvay Process Company. **W. R. C. CORSON**, Hartford; for New England. He has been actively engaged in practice as a consulting engineer.

MR. H. S. WETZEL, formerly chief chemical engineer of the Pittsburgh-Buffalo Coal Co., has resigned to accept a position with the National Carbon Company of Niagara Falls, N. Y.

Obituary

MR. ROBERT BROWN CARNAHAN, JR., vice president of The American Rolling Mill Co., was killed in an accident on June 22, 1918. After graduating from the University of Pittsburgh in 1891, Mr. Carnahan was actively associated with the Dewees-Wood Company at McKeesport, Pa. from 1893 to 1899, when he went to the Homestead Works of the Carnegie Steel Co., soon after which he went into the present central works of The American Rolling Mill Co. as chief chemist and open hearth superintendent. It was under Mr. Carnahan's direction that Armco American Ingot Iron was developed. Mr. Carnahan was a member of The American Iron and Steel Institute, The American Institute of Mining Engineers and The American Society For Testing Materials. His alma mater conferred the honorary degree of Doctor of Science upon him in 1912.

DR. EDGAR MARBURG, secretary-treasurer of the American Society for Testing Materials, and professor of Civil Engineering in the University of Pennsylvania, died June 27, 1918, the news of his death being received during the twenty-first meeting of the Society.

Current Market Reports

Non-Ferrous Metal Market

Monday, July 8:—Prices have a tendency to rise due to the 25% freight rate increase.

Aluminium:—The government price is 30c. a pound f.o.b. plant in 50-ton lots, 33.1c. down to 15-ton lots, and 33.2c. in lots down to 1 ton, 40c. to 45c. for smaller lots.

Antimony:—Demand is quiet but large orders are expected. Spot antimony, duty paid, is quoted at 13c. to 13½c.

Chrome:—Producers have established a schedule on the basis of \$1.30 per unit ore; some 40% ore has sold for \$1.50 per unit.

Copper:—The price has been advanced to 26c., an increase of 2½c., about one-half of which is to go to an increased refinery rate.

Lead:—The basic fixed price at East St. Louis is 7½c. New York is short and prices vary from 8.05c. to 8.25c.

Manganese:—Variable ton unit scale price, 40 per cent \$1.10, 50 per cent \$1.20. For full specifications see Metallurgical and Chemical Engineering, page 629, June 15.

Manganese:—Variable ton unit scale price: 40%, \$1.10; 50%, \$1.20. For full specifications see METALLURGICAL AND CHEMICAL ENGINEERING, page 629, June 15.

Molybdenum:—Quoted at \$1.25 per pound for 90% molybdenum sulphide.

Silver:—Sixty-four million silver dollars have been melted into bullion by the U. S. Treasury, for export to India. The Treasury still holds 426,000,000 silver dollars, against which \$390,000,000 silver certificates are outstanding. Silver is quoted at 99½c. per troy ounce.

Spelter:—Buying not heavy. Prime western is quoted at New York at 8.67½c. to 8.87½c. for July; at East St. Louis, 8½c. to 8¾c., futures to October 8.55c. to 8.80c.

Tin:—Conservative buying. At Coast, Banca is offered at 91c. At New York, Lamb and Flagg at 94c., Straits for August shipment at 87½c. Large consumers importing direct.

Tungsten:—The highest grade material containing no tin, no copper, low manganese and over 70% WO₃ has brought \$24.00 per ton unit. Impure material has sold as low as 95c. per pound WO₃ contained.

Bismuth	\$3.50
Cadmium	\$1.40 — 1.50
Nickel	\$0.40 — .43
Platinum oz.	\$1.05
Palladium oz.	\$1.35
Cobalt	\$2.50 — 3.50
Magnesium	\$1.75 — 2.00
Quicksilver California (75 lb.)	\$125.00
Mexican (75 lb.)	\$118.00

The Iron and Steel Market

While the stiff freight rate advance of June 25 bears very heavily upon the merchant blast furnaces, particularly as the advance of 45 cents a ton in Lake Superior ore allowed by the War Industries Board passes the rate advance on Lake Superior ore on to the blast furnaces, the chief complaint of blast furnaces that there is too little margin between costs and the permissible maximum selling prices, or no margin at all, comes from furnaces in Tennessee and Virginia, and arises largely from quite unsatisfactory labor performance. The effect upon negro labor of successive wage advances has been particularly unfortunate, as to make living expenses it is quite unnecessary to work full time, and the men sometimes work as few as two days a week, interfering sadly with full operation, while performance when on duty is far below standard. There are various other difficulties, but the matter of labor presents the most serious problem. While a few of the furnaces have been advocating a higher selling price, it is the common opinion that the matter must be approached from some other angle. The American Pig Iron Association has held two general meetings on the subject, the details of the discussion not being made public.

PROFITS AND TAXATION

The steel manufacturers as a whole are well satisfied with the price situation, as with few exceptions the allowed prices afford very comfortable profits. The manufacturers are concerned chiefly with production, being anxious to have full output in order to meet fully all the desires of the Government and incidentally to keep down costs, which mounted very seriously last January and February, with the average of 55 to 60 per cent operation which obtained in those months.

There has been a little criticism in some quarters of the report the Federal Trade Commission recently made to the Senate as to profits in various industries, and it is evident that the critics did not digest the report or they would have been able to find no reasonable fault with the references to the iron and steel industry. The Senate called for the report, by resolution, for the double purpose of securing information that would be helpful in the taxation program and of receiving light on how profiteering might be regulated by law. As to the latter phase of the general inquiry the Federal Trade Commission could make no reference in the case of iron and steel, for the reason that all iron and steel prices are controlled strictly by the War Industries Board, under approval of the President, and the regulating authorities are well satisfied with the situation. The Federal Trade Commission, moreover, has an important voice in the settling of iron and steel prices, the War Industries Board depending largely upon its findings as to costs, and also upon its judgment. As a matter of fact the report in question made absolutely no attempt to criticize the existing iron and steel prices. The report did show that the industry as a whole is making very large profits, but as Congress is seeking profits for the purpose of taxing them, with an eight billion dollar revenue program before it, the reference was decidedly fitting. The report did not criticize the iron and steel industry in any respect. The "meat trust" on the other hand was scored severely, while the accounting and other methods employed by some industries that are allowed a margin above cost, particularly the flour milling industry, were severely criticized. At-

tention was directed to the fact that in industry in general there are many instances of wide divergencies in cost, whereby a given price may afford one manufacturer a small profit and another a large profit, this being distinctly suggestive of the desirability of a general policy of having relatively high prices and of taxing excess profits very heavily. On the whole the report furnishes some ground for expectation that there will not be much effort made to reduce iron and steel prices, while excess profits will be heavily taxed.

LABOR AND PRODUCTION

It is becoming increasingly clear that in the matter of production it is not so much a question of the number of workmen available as a whole as it is a question of their performance. The Government is insisting that after August 1 employers engaged in war work shall recruit labor through no channel but the federal employment offices organized by the Department of Labor. There has been much waste of labor through labor recruiting methods which may have benefited the employers who practiced them, but certainly injured other employers. The iron and steel producers feel that they have suffered much more than they have benefited from the recruiting of labor by the payment of bonuses, and other unusual methods, and hopes for better conditions when the federal employment system is made the sole means of employing labor.

SOLUTION OF PROBLEM

The American Sheet & Tin Plate Company has put into operation a system of its own devising for stimulating activity among its employees, and finds even the first experience in this connection very satisfactory, definite and valuable results being observed within the first fortnight of the system's application. The first operation was to post notices at all the company's plants, 13 sheet plants and 14 tin plate plants, to the effect that all employees would be solicited to sign a pledge for 100 per cent. efficiency. The men became interested at once, and began calling for the pledge cards, which were being prepared as rapidly as possible. Each card carries the pledge in English and in some foreign language. The workman signs the pledge card and returns it to the manager. A record is made and the signed pledge is returned to the man, who knows that the company has a record of his having signed the pledge, which obligates him: (1) Not to absent himself from work except when absolutely necessary; (2) to work faithfully when on duty; (3) to make every effort to induce his fellow workmen to do likewise. There is a series of four buttons, each with the inscription "100 per cent efficiency man," white upon signing the pledge, red upon keeping it for 30 days, blue for 60 days and red, white and blue for 90 days, the 90-day service involving also a "service certificate." The idea took hold so well that men began forming "efficiency clubs" providing a fine of \$1, to go to the Red Cross, for avoidable absence. The company employs men speaking 59 languages, only a fraction of this number being represented at any one plant. A record of attendance at work is kept, quite apart from the payroll, and each case of absence is investigated, unavoidable absences being excused.

DISTRIBUTION

Supplies of merchant pig iron and of steel are in the main not sufficient to cover entirely the preference list, after direct and indirect government orders are satisfied, and as a result scarcely any material is being distributed to the general trade, not accorded any preference. The preference uses, however, are so numerous that there are but few requirements of a general commercial character not covered. Buyers not entitled to preference, moreover, have some stocks of material and supplies may become available for them before present stocks are exhausted. The war activities are in many cases receiving more material than is currently consumed, this being in accordance with the desire of the Director of Steel Supply, that surpluses be accumulated, particularly in connection with shipbuilding and shell manufacture, to provide against possible curtailment in production and shipments next winter. The

manufacture and consumption of steel for war purposes is proceeding in a very satisfactory manner.

STRUCTURAL STEELS.

Tank Plates, Sheets, etc., per ton.....	70.00—80.00
Beams, Channels, Z's, T's, L's, wire, etc.....	65.00—85.00
Rivets, Spikes, Rails, etc.....	88.00—100.00
Tin Plate, Tern, etc.....	150.00—155.00
Galvanized Sheets, etc.....	104.00—125.00

Chemical Market

HEAVY CHEMICALS:—In general the period of the last two weeks has been very quiet but marked by some little activity in caustic soda which is considered the barometer of conditions of the present. There developed considerable call for sodium sulphide, saccharine and calcium carbide but as is usual under a heavy inquiry, stocks were very meagre.

Trisodium Phosphate: For material in carload lots interests are quoting 5c per pound f.o.b. New York with smaller quantities available at 5¼c. Inquiry was not active and although stocks are not heavy there apparently is confidence in ability to supply the demand. There is also material at hand available for export.

Caustic Soda: The situation is causing considerable comment and the unusually quiet conditions prevailing do not seem to indicate any improvement for the near future at least. Material rolling to New York is thought to amount to a rather important tonnage and buyers are seemingly fully aware of this situation and are awaiting developments before attempting to enter the market. Some stocks were held as low as 3.80 and 3.90 rolling, but generally these were brands not in particular favor. For standard brands such as 76 from 4.15 to 4.30 is being asked ex-store New York.

Soda Ash: The dense material has been very hard to locate but has been in strong demand for Western shipment with prices quoted at 3.80 f.o.b. Western works. The light ash is being offered at from 2.10 to 2.15 in bags, spot New York and at from 2.80 to 2.85 in barrels and up to 2.90 in some instances.

Sulphuric Acid: The notable feature on this item and of great moment to the trade was the definite announcement from Washington that the War Trade Board has definitely fixed the maximum trading levels for acids. The 66 degree material is fixed at \$28.00 f.o.b. works in sellers tanks. The 60 degree material is to sell at a maximum level of \$18.00 same basis. The basis for fuming acid, 20% oleum is \$32.00 per ton. In carboy carload lots one-half cent per pound extra is allowed and in carboys less than carloads three quarters of a cent per pound extra is allowed. In drums any quantity one-half cent per pound extra is allowed. So far the trade is without more definite advices and until the ruling in detail is explained matters will be rather complicated. It has been made plain however that the price setting is not to be retroactive and that contracts now in effect or those which have not yet been completed, will not be affected unfavorably.

Nitric Acid: Forty-two degrees Baumé 8½c per pound, f.o.b. manufacturers' works in carboys. Other strengths of nitric acid based upon the above prices are as follows:

Nitric Acid	36 degrees Baumé	\$0.0660 per pound
Nitric Acid	38 degrees Baumé	.0715 per pound
Nitric Acid	40 degrees Baumé	.0775 per pound
Nitric Acid	42 degrees Baumé	.0850 per pound
Nitric Acid	43 degrees Baumé	.0890 per pound

A schedule of prices on mixed acids is being prepared and will be published later.

The above maximum prices are agreed upon for the public, as well as for Government purchases. It is understood and agreed that any deliveries made after September 30th will be subject to any revision in price which the Government may make for deliveries after that date. The above prices do not in any way interfere with contracts now in effect and which have not yet been completed. It is understood that carboys are to be invoiced as shipments are made, and credit issued when returned in good order.

Potassium Permanganate: Prices asked for spot material are holding steady although the market has been quiet, in general with most other items. The U. S. P. material is ranging from 2.50 to 2.60 per pound and about 2.25 to

2.30 for the technical grade. For the U. S. P. on contract there is concession to the extent of from ten to twenty-five cents.

Sal Ammoniac: With the diminishing of supplies the tendency has been for the raising of the asking price and it has been noted that a considerable quantity of the gray material has been passed at 22c, rolling. There has been a very steady demand.

COAL TAR PRODUCTS: The general tendency in this market has been toward an advance in prices although things have been rather quiet particularly in the latter part of the two weeks period owing to the holiday. One of the most notable occurrences was the direct reversal of relations between the two saccharines.

Phenol: There are many conflicting rumors concerning supply, demand, exports and imports and also with regard to governmental attitude; but as near as it is possible at present to gain them the facts appear to be that there is a very small unsold or uncontracted-for supply of phenol available today. The demand has been very good; export licenses are continuing to be granted and there is some mystification as to the reasons for the importations of the English phenol, arrivals of which have been reported as there is for even the offerings which are known to have been made, because of the undoubted requirements of the British Government itself for this product. The question remains unanswered as does also the one with regard to exportations from this country when it is known that although the U. S. Government has contracted for all requirements up to date they are placing large contracts for future deliveries of millions of pounds to take care of estimated monthly needs and still are not confident that the production will keep pace with the growing need for and production of picric acid. It is felt however that such government orders do not have a direct affect upon the resale market. Sales have been made of large quantities at 44c which is very close to that which the English material would bring with all duties paid. General quotations on resale continue at, and the market is judged to be from, 45 to 48c.

Paranitraniline: Inquiry on this item has been very good but material is said to be scarce and holders few. Those who have material to offer are doing so in very small quantities. Prices show a tendency to advance as some holders are asking ten cents more on the small lots offered than was asked a few days ago. Actual sales are reported of five barrel quantities at 1.85.

H-Acid: Production is centered in a few hands and the demand has evidently absorbed the supplies for July as factors are reticent about quoting on material for earlier than August shipment. The prices quoted show a tendency toward a rise as 2.60 is now the lowest heard and in some directions there is refusal to accept less than 2.75. For the highest grades however no quotations have yet been heard in excess of 3.00.

Saccharines: The soluble material has been in extraordinary demand with holders hard to locate. Relations as to price and demand have reversed themselves as between the two grades in that the soluble has actually passed at 29.00 and 30.00 with the insoluble now at from 22.00 to 23.00.

Dinitrophenol: Quotations on material for shipment f.o.b. works run from 55 to 60c according to quantity. Supplies are said to be available to cover all needs at least in the present state of the market as the inquiry for this product is but fair and actual sales but few.

Monochlorbenzol: Some factors are completely sold up on stocks for the balance of the year on contract but from certain sources plenty of the product is obtainable at the prices of from 17 to 19c according to quantity desired. Inquiry however has been slow.

Benzoate of Soda: Prices for the soda continue to be quoted at from 3.00 to 3.25 and for the acid at from 3.45 to 3.70, however, it is rumored that both of these products are to be advanced in the near future as the prices at which they have been holding are so close to manufacturing cost as to not permit of profitable business on present demands.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JULY 8, 1918

Acetic anhydride.....	lb.	1.60	—	1.85
Acetone, drums.....	lb.	Nominal		
Acid, acetic, 28 per cent.....	lb.	Nominal		
Acetic, 56 per cent.....	lb.	Nominal		
Acetic, glacial, 99½ per cent, carboys.....	lb.	Nominal		
Boric, crystals.....	lb.	.134	—	.15
Citric, crystals.....	lb.	.82	—	.88
Hydrochloric, C. P.....	lb.	Nominal		
Hydrochloric, 20 deg.....	lb.	.02	—	.02½
Hydrochloric, conc., 22 deg.....	lb.	.02½	—	.03
Hydrofluoric, 30 per cent in barrels.....	lb.	.06	—	.06½
Lactic, 44 per cent.....	lb.	.15	—	.16
Lactic, 22 per cent.....	lb.	.06	—	.07
Molybdic, C. P.....	lb.	6.90	—	7.40
Nitric, 36 deg.....	lb.	Nominal		
Nitric, 42 deg.....	lb.	.08½	—	.10
Oxalic, crystals.....	lb.	.43	—	.45
Phosphoric, 47-50 per cent paste.....	lb.	.08	—	.10
Phosphoric, ref. 50 per cent.....	lb.	.35	—	.40
Picric.....	lb.	Nominal		
Pyrogallol, resublimed.....	lb.	3.10	—	3.15
Sulphuric, 60 deg.....	ton	Nominal		
Sulphuric, 66 deg.....	ton	Nominal		
Sulphuric, oleum (Fuming), tank cars.....	ton	Nominal		
Tannic, U. S. P., bulk.....	lb.	1.40	—	1.45
Tartaric, crystals.....	lb.	.86	—	.89
Tungstic, per lb. of W.....	lb.	1.70	—	1.75
Alcohol, sugar cane, 188 proof.....	gal.	4.89	—	4.90
Alcohol, wood, 95 per cent.....	gal.	.904	—	.91
Alcohol, denatured, 180 proof.....	gal.	.67	—	.68
Alum, ammonia lump.....	lb.	.04	—	.04½
Alum, chrome ammonium.....	lb.	.18	—	.19
Alum, chrome potassium.....	lb.	.20	—	.21
Alum, chrome sodium.....	lb.	.12½	—	.13
Alum, potash lump.....	lb.	.08	—	.09
Aluminium sulphate, technical.....	lb.	.02½	—	.03
Aluminium sulphate, iron free.....	lb.	.03½	—	.04
Ammonia aqua, 26 deg., carboys.....	lb.	(Fixed Price)		
Ammonia, anhydrous.....	lb.	Nominal		
Ammonium carbonate.....	lb.	.15	—	.16
Ammonium nitrate.....	lb.	(Fixed Price)		
Ammonium sulphate domestic.....	lb.	.07½	—	.08
Amyl acetate.....	gal.	5.15	—	5.25
Arsenic, white.....	lb.	.094	—	.17
Arsenic, red.....	lb.	.65	—	.70
Barium carbonate, 99 per cent.....	ton	80.00	—	90.00
Barium carbonate, 97-98 per cent.....	ton	65.00	—	67.00
Barium chloride.....	ton	65.00	—	70.00
Barium sulphate (Blanc Fixe, Dry).....	lb.	.04½	—	.05
Barium nitrate.....	lb.	.10	—	.11
Barium peroxide, basis 70 per cent.....	lb.	.30	—	.32
Bleaching powder, 35 per cent chlorine.....	lb.	.02	—	.03
Borax, crystals, sacks.....	lb.	.07½	—	.08½
Brimstone, crude.....	ton	Nominal		
Bromine, technical.....	lb.	.75	—	.....
Calcium, acetate, crude.....	lb.	Nominal		
Calcium, carbide.....	lb.	.15	—	.16
Calcium chloride, 70-75 per cent, fused, lump.....	ton	22.00	—	24.00
Calcium peroxide.....	lb.	1.60	—	1.70
Calcium phosphate.....	lb.	.22	—	.23
Calcium sulphate 98-99 per cent.....	lb.	.09	—	.09½
Carbon bisulphide.....	lb.	.08½	—	.09
Carbon tetrachloride, drums.....	lb.	.15½	—	.18
Carbonyl chloride (phosgene).....	lb.	1.10	—	1.50
Caustic potash, 88-92 per cent.....	lb.	.82	—	.83
Caustic soda, 76 per cent.....	100	4.00	—	4.25
Chlorine, liquid.....	lb.	(Fixed Price)		
Cobalt oxide.....	lb.	1.60	—	1.65
Copperas.....	lb.	.01½	—	.....
Copper carbonate.....	lb.	.29	—	.32
Copper cyanide.....	lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals.....	lb.	.08½	—	.09½
Cream of tartar, crystals.....	lb.	.77	—	.78
Epsom salt, bags, U.S.P.....	lb.	3.62½	—	3.90
Formaldehyde, 40 per cent.....	lb.	.16½	—	.17½
Glauber's salt.....	100	1.50	—	1.75
Glycerine, bulk, C. P.....	lb.	.62	—	.65
Iodine, resublimed.....	lb.	4.25	—	4.30
Iron oxide.....	lb.	.13	—	.15
Lead acetate, white crystals.....	lb.	.17	—	.18
Lead arsenate (Paste).....	lb.	.15	—	.18
Lead nitrate.....	lb.	Nominal		
Litharge, American.....	lb.	.10½	—	.12½
Lithium carbonate.....	lb.	1.50	—	2.00
Manganese dioxide, U. S. P.....	lb.	.70	—	.75
Magnesium carbonate, technical.....	lb.	.12	—	.13
Nickel salt, single.....	lb.	.14	—	.15
Nickel salt, double.....	lb.	.12	—	.14
Phosgene, see Carbonyl chloride.....				
Phosphorus, red.....	lb.	1.20	—	1.30
Phosphorus, yellow.....	lb.	1.00	—	1.25
Potassium bichromate.....	lb.	.46	—	.47
Potassium bromide granular.....	lb.	1.35	—	1.50
Potassium carbonate calcined, 85-90 per cent.....	lb.	.48	—	.50
Potassium chlorate, crystals.....	lb.	.38	—	.40
Potassium cyanide, 98-99 per cent.....	lb.	Nominal		
Potassium iodide.....	lb.	3.75	—	3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.....	ton	300.00	—	350.00
Potassium nitrate.....	lb.	.27	—	.31
Potassium permanganate (U. S. P.).....	lb.	2.50	—	3.25
Potassium prussiate, red.....	lb.	2.80	—	2.90
Potassium prussiate, yellow.....	lb.	1.10	—	1.20
Potassium sulphate, 90-95 p. c. basis 90 p. c.....	ton	Nominal		
Rochelle salts.....	lb.	.44½	—	.46
Salammoniac, gray gran.....	lb.	.22	—	.23
Salammoniac, white gran.....	lb.	.20	—	.21
Sal soda.....	100	1.35	—	1.40
Salt cake.....	ton	30.00	—	35.00
Silver cyanide, based on market price of silver.....	oz.	.....	—	.....
Silver nitrate.....	oz.	.62½	—	.63
Soda ash, 58 per cent, light, flat (bags).....	100	2.10	—	2.15
Soda ash, 58 per cent, dense, flat.....	100	3.65	—	4.00
Sodium acetate.....	lb.	Nominal		
Sodium bicarbonate, domestic.....	lb.	.03	—	.03½
Sodium bicarbonate, English.....	lb.	.....	—	.....
Sodium bichromate.....	lb.	.27½	—	.29

Sodium bisulphite, powder	lb.	.06	—	.06
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.40	—	.42
Sodium fluoride, commercial	lb.	.17	—	.18
Sodium hyposulphite	lb.	2.40	—	2.50
Sodium molybdate, per lb. of Mo.	lb.	2.50	—	—
Sodium nitrate, 95 per cent	100 lb.	Nominal	—	—
Sodium nitrite	lb.	.28	—	.30
Sodium peroxide	lb.	.35	—	.45
Sodium phosphate	lb.	.04	—	.05
Sodium prussiate, yellow	lb.	.60	—	.63
Sodium silicate, liquid (60 deg.)	lb.	Nominal	—	—
Sodium sulphide, 30 per cent, crystals	lb.	Nominal	—	—
Sodium sulphide, 60 per cent, fused	100 lb.	Nominal	—	—
Sodium sulphite	lb.	Nominal	—	—
Strontium nitrate	lb.	.25	—	.35
Sulphur chloride, drums	lb.	.06	—	.06
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.60
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	Nominal	—	—
Tin bichloride, 50 deg.	lb.	.28	—	.29
Tin oxide	lb.	1.00	—	1.25
Zinc carbonate	lb.	.22	—	.24
Zinc chloride	lb.	.15	—	.18
Zinc cyanide	lb.	Nominal	—	—
Zinc dust, 350 mesh	lb.	.14	—	.16
Zinc oxide, American process XX	lb.	.13	—	.14
Zinc sulphate	lb.	.05	—	.06

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.23	—	.28
Benzol, 90 per cent	gal.	.25	—	—
Toluol, in tank cars	gal.	(Fixed Price)	1.50	—
Toluol, for non-military use, in drums	gal.	(Fixed Price)	1.55	—
Xylol, pure, water white	gal.	.45	—	.55
Solvent naphtha, water white	gal.	.18	—	.28
Solvent naphtha, crude, heavy	gal.	.12	—	.15
Cresote oil, 25 per cent	gal.	.39	—	.40
Dip oil, 20 per cent	gal.	.30	—	.32
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.35	—	.38
Cresol, U. S. P.	lb.	.18	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	—	1.10
Alpha naphthol, distilled	lb.	1.60	—	1.70
Alpha naphthylamine	lb.	.60	—	.65
Aniline oil, drums extra	lb.	.27	—	.28
Aniline salts	lb.	.34	—	.36
Anthracene, 80 per cent	lb.	Nominal	—	—
Benzaldehyde (f.f.c.)	lb.	3.65	—	—
Benziline, base	lb.	1.75	—	2.00
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid U. S. P.	lb.	3.40	—	3.60
Benzoate of Soda, U. S. P.	lb.	3.00	—	3.25
Benzyl chloride	lb.	2.30	—	2.50
Beta naphthol b. nzoate	lb.	10.00	—	12.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamine, sublimed	lb.	2.65	—	—
Dichlor benzol	lb.	.15	—	.20
Diethylaniline	lb.	4.50	—	5.00
Dinitro benzol	lb.	.36	—	.38
Dinitrochlorbenzol	lb.	.40	—	.42
Dinitronaphthalene	lb.	.60	—	.70
Dinitrotoluol	lb.	.65	—	.75
Dinitrophenol	lb.	.46	—	.50
Dimethylaniline	lb.	.75	—	.80
Diphenylamine	lb.	.75	—	1.00
H-acid	lb.	2.60	—	3.00
Metaphenylenediamine	lb.	.17	—	.20
Monochlorbenzol	lb.	.08	—	.09
Naphthalene, flake	lb.	.10	—	.10
Naphthalene, balls	lb.	.10	—	.10
Naphthionic acid, crude	lb.	1.20	—	1.30
Naphthylamin-di sulphonic acid	lb.	1.00	—	1.10
Nitro naphthalene	lb.	.45	—	.50
Nitro toluol	lb.	.60	—	.65
Ortho-amidophenol	lb.	.15	—	.18
Ortho-dichlor-benzol	lb.	1.00	—	1.25
Ortho-toluidine	lb.	.75	—	1.00
Ortho-nitro-toluol	lb.	4.00	—	4.50
Para-amidophenol, base	lb.	4.00	—	5.00
Para-dichlor-benzol	lb.	.15	—	.20
Paranitraniline	lb.	1.60	—	1.85
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine (base)	lb.	3.75	—	4.00
Para-toluidine	lb.	2.00	—	2.25
Phthalic acid anhydride	lb.	3.50	—	4.00
Phenol, U. S. P.	lb.	.44	—	.50
Resorcin, technical	lb.	5.00	—	7.00
Resorcin, pure	lb.	8.00	—	9.00
S. lyeilic acid	lb.	1.50	—	1.10
Solol	lb.	1.50	—	2.00
Sulphanilic acid, crude	lb.	.30	—	.32
Tolidin	lb.	2.50	—	—
Toluidine-mixture	lb.	.85	—	.90

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	—	—
Corning, Ohio	bbl.	2.85	—	—
Somerset, Ky.	bbl.	2.60	—	—
Wooter, Ohio	bbl.	2.68	—	—
Indiana	bbl.	2.42	—	—
Illinois	bbl.	2.42	—	—
Oklahoma and Kansas	bbl.	2.25	—	—
Caddo, La., light	bbl.	2.25	—	—
Corriana, Tex., light	bbl.	2.25	—	—

California	bbl.	1.24	—	1.57
Gulf Coast	bbl.	1.35	—	—
Fuel Oil				
New York	gal.	.15	—	—
Pittsburgh	gal.	.07	—	.10
Oklahoma-Kans.	bbl.	1.05	—	2.75
Texas	bbl.	1.85	—	2.35
Los Angeles	bbl.	1.60	—	—
San Francisco	bbl.	1.60	—	—

Gasoline (Wholesale)

New York	gal.	.24	—	—
Boston	gal.	.25	—	—
Pittsburgh	gal.	.28	—	—
Chicago	gal.	.22	—	—
Oklahoma	gal.	.25	—	—
San Francisco	gal.	.20	—	—

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.23	—	.24
Cylinder, light	gal.	.38	—	.39
Cylinder, dark	gal.	.35	—	.36
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, .903 sp. gr.	gal.	.36	—	.38
Paraffine, .885 sp. gr.	gal.	.26	—	.28

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	—
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.58	—	.60
Pine oil, destructively distilled	gal.	.58	—	.60
Pine-tar oil, sp. gr. 1.02-1.035	gal.	.35	—	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—	—
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f. o. b. works	gal.	.37	—	—
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f. o. b. works	gal.	.28	—	—
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	—
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.45	—	—
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	—
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	—
Wood creosote, ref. f. o. b. Florida	gal.	.31	—	—

Vegetable and Other Oils

China wood oil	lb.	.26	—	.29
Cottonseed oil, crude	lb.	.20	—	.22
Linseed oil, raw, cars	gal.	1.64	—	1.66
Peanut oil, crude	gal.	1.36	—	1.36
Rosin, oil, fat run	gal.	.60	—	—
Rosin oil, fourth run	gal.	.73	—	—
Soya bean oil, Manchuria	lb.	.18	—	—
Turpentine, spirits	gal.	.77	—	—

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	42.00
Barytes, floated, white, domestic	ton	32.00	—	36.00
Becawax, white, pure	lb.	.42	—	.43
Casoin	lb.	.14	—	.28
Chalk, light, precipitated, English	lb.	Nominal	—	—
China clay, imported, lump	ton	17.50	—	36.00
China clay, domestic, lump	ton	12.50	—	20.00
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f. o. b. mines	ton	30.00	—	—
Fuller's earth, powdered	100 lb.	1.50	—	2.00
Graphite, flake	lb.	.10	—	.25
Osokerite, crude	lb.	.75	—	.80
Osokerite, American, refined, white	lb.	.85	—	.90
Red lead, dry, carloads	lb.	.10	—	.11
Rosin, 280 lb.	bbl.	11.00	—	12.50
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	35.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F. O. B. Works)

Chrome brick	net ton	175.00	—	—
Chrome cement	net ton	75.00	—	—
Clay brick, 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	50.00	—	65.00
Magnesite, dead burned	net ton	110.00	—	125.00
Magnesia brick, 9x4x2	net ton	110.00	—	125.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocobaltitium, 15-18 per cent, carloads, f. o. b. Niagara Falls, N. Y.	ton	15.00	—	20.00
Ferrocobaltium	lb.	—	—	—
Ferrocobaltium, per lb. of Cr.	ton	250.00	—	—
Ferromanganese, domestic, 70 per cent basis	ton	325.00	—	—
Ferromanganese, English	ton	5.00	—	—
Ferromolybdenum, per lb. of Mo.	ton	180.00	—	190.00
Ferrosilicon, 75 per cent, f. o. b. N. Y.	ton	160.00	—	170.00
Ferrosilicon, 50 per cent, carloads, del. Pittsburgh	ton	2.35	—	2.40
Ferrosilicon, 50 per cent, contract	lb.	7.50	—	—
Ferrotungsten, 75-85 per cent, f. o. b. Pittsburgh	lb.	—	—	—
Ferroumium, f. o. b. works, per lb. of U.	lb.	—	—	—
Ferrovanadium, f. o. b. works	lb.	—	—	—

Ores and Semi-finished Products

Antimony ore, per unit	ton	Nominal	—	—
Chrome ore, 45 per cent minimum, f. o. b. Cal. per unit	ton	1.50	—	1.55
Chrome ore, 43 per cent and over, New York, per unit	ton	1.20	—	—
Manganese ore, 48 per cent and over, per unit	ton	80.00	—	100.00
Manganese ore, chemical	ton	24.00	—	—
Molybdenite, per lb. of MoS ₂	lb.	24.00	—	—
Tungsten, Scheelite, per unit of WO ₃	ton	3.25	—	3.60
Tungsten, Wolframite, per unit of WO ₃	ton	10.50	—	—
Uranium oxide, 96%	lb.	.17	—	.17
Vanadium pentoxide, 99%	unit	.28	—	.30
Pyrites, foreign	unit	—	—	—
Pyrites, domestic	unit	—	—	—

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

FORT SMITH.—The Arkansas Mining & Mercantile Co., Boone and Marion Counties, will build a 200-ton concentration plant requiring drills, sludge and slime tables, engines, pits, boilers, compressors, ore crushers, track, cars, belts and mill hardware. Estimated cost, \$60,000. F. A. Handlen, superintendent.

Connecticut

COSCOB.—The Mianus Manufacturing Co., 615 Fourth Ave., New York City, will build a 4-story, 42 x 145 ft. reinforced concrete dyehouse here. Estimated cost, \$40,000. Lockwood Greene Co., 101 Park Ave., New York City, engineers.

NEW BRITAIN.—The Traut & Hine Manufacturing Co., 910 Stanley St., has awarded the contract for the construction of a 1 and 3-story, 43 x 83 and 44 x 70 ft. concrete and brick addition to its factory for the manufacture of metal novelties, to W. H. Allen, New Britain. Estimated cost, \$35,000.

TORRINGTON.—The Fitzgerald Manufacturing Co. will build a 2-story, 50 x 300 ft. concrete and brick factory for the manufacture of brass goods on Railroad Ave. Estimated cost, \$60,000. E. H. Waterbury, Torrington, architect.

Georgia

BRUNSWICK.—The Ordinance Division, War Department, Washington, D. C., has awarded the contract for the construction of a picric acid plant here, to Butterworth-Judson Co., 61 Broadway, New York City. Estimated cost, \$7,000,000.

Indiana

KOKOMO.—The Kokomo Steel & Wire Co. will build a 1-story, 100 x 800 ft. reinforced concrete and brick factory. Estimated cost, \$150,000.

Kansas

BAXTER SPRINGS.—The Great Western Mining Co. will build a 500-ton concentration plant requiring lumber, engine, boilers, sludge tables, belts, crushers, hardware and scales. Estimated cost, \$75,000. O. F. Reneger, superintendent.

BAXTER SPRINGS.—C. M. Mitchell will build a 200-ton concentration plant at his mine here and install mill hardware, lumber, sludge and slime tables, engine, boiler, crusher, air compressor and belts. Estimated cost, \$45,000. Buck Shelton, Baxter Springs, superintendent.

BAXTER SPRINGS.—C. E. Phillips will build a 150-ton concentration plant. Estimated cost, \$60,000. The company is in the market for sludge and slime tables, mill hardware, ore cars, lumber, drills, engines, boilers, belts. John Phillips, superintendent.

GALENA.—O. C. Hamilton, Connor Hotel, Joplin, Mo., will build a 200-ton concentration plant at his mine here and is in the market for ore crushers, ore cars, lumber, mill hardware, sludge and slime tables, air compressors, pipes and belts. Estimated cost, \$65,000.

GALENA.—The Lucky Jim Mining Co. will build a 200-ton concentration plant and install machinery, including sludge and slime tables, crushers, lumber mill hardware, belts, air compressors and drills. Estimated cost, \$25,000. O. C. Hamilton, Galena, superintendent.

GALENA.—The Stag Mining Co. will build a 200-ton concentration plant and install machinery, including sludge and slime tables, ore crushers, lumber, drills and compressors. Estimated cost, \$60,000. F. L. Cook, superintendent.

GALENA.—The Stag Mining Co. will remodel its 150-ton mill to a 250-ton mill. Estimated cost, \$25,000. The company is in the market for lumber, mill hardware, belts, crushers, air compressors, ore bins, cars, track and drill. R. S. Harris, superintendent.

TREECE.—The Phoenix Lead & Zinc Co., Phoenix, will remodel its 200-ton mill and install belts, rollers, track, hardware and ore cars. Estimated cost, \$25,000.

Kentucky

LOCKLAND.—J. B. Speed & Co., Speed Building, Louisville, will build a potash plant. Estimated cost, \$100,000.

LOUISVILLE.—The Magic Keller Soap Works, 2745 Stoeker St., has awarded the contract for the construction of a factory to the National Concrete Construction Co., engineers, Board of Trade Building.

Louisiana

ALEXANDRIA.—The Wm. Polk Co., 1209 Third St., will build a plant for manufacturing soap stocks, etc. Wm. Polk, care company, interested.

Maryland

BALTIMORE.—The American Can Co., Maryland Trust Building, will build a 4-story, 36 x 105 x 176 ft. reinforced concrete, brick and steel factory on Boston and Hudson Sts., Canton. Estimated cost, \$180,000. N. M. Loney, 120 Broadway, New York City, architect.

BALTIMORE.—The Baltimore Tube Co., Wicomico and Ostend Sts., has purchased a site at Wicomico and Bayard Sts., and will build an addition to its plant here.

BALTIMORE.—The Bartlett-Hayward Co., Scott and McHenry Sts., has awarded the contract for the construction of a 1-story, 479.5 x 618 ft. frame munition factory, to Morrow Bros., Fidelity Building. Estimated cost, \$10,000.

BALTIMORE.—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will build additional buildings at Marine Hospital, Remington Ave. and 31st St., including laboratories. Dr. C. W. Vogel, in charge.

BALTIMORE.—Elliott Machine Corporation, Bush and Severn Sts., will build a 1-story, 50 x 125 ft. concrete and steel tool machine shop at Bayard and Wicomico Sts. Estimated cost, \$75,000.

INDIAN HEAD.—Bureau of Yards & Docks, Navy Department, Washington, D. C., will build 11 buildings as an extension to its powder factory. Estimated cost, \$338,500.

Michigan

BATTLE CREEK.—The Rich Steel Products Co. has awarded the contract for the construction of a 1-story, 49 x 112 ft. warehouse and a 49 x 256 ft. shop, mill construction, to C. Rasmussen, 254 West Randolph St., Chicago, Illinois.

Missouri

DÜENWEG.—Frank Starkweather will rebuild the 150-ton concentration plant recently destroyed by fire. Estimated cost, \$45,000. The company is in the market for sludge and slime tables, lumber, mill hardware, drills, boilers, engines, track and ore cars. F. Starkweather, superintendent.

DÜENWEG.—The Vacation Mining Co. will build a 200-ton concentration plant. Estimated cost, \$65,000. The company is in the market for sludge and slime tables, mill hardware, ore cars, track engine, boilers, air compressors, belts, drills and crushers. Bud Craig, Joplin, superintendent.

KANSAS CITY.—C. R. Cook Paint Co., 2107 Broadway, will rebuild its plant recently destroyed by fire entailing a loss of \$40,000.

ORONOGO.—The Connecticut Zinc Corporation, Joplin, will build an 1800-ton concentration plant here and install machinery, including sludge and slime tables, air compressors, belts, ore cars, crushers, scales, drills, engines, mill hardware, lumber and roofing. Estimated cost, \$200,000. Sidney Wilkens, Independent Bldg., Joplin, superintendent.

WACO.—The George Ball Mining Co. will build a 150-ton concentration plant. Estimated cost, \$60,000. The company is in the market for sludge and slime tables, crushers, jigs, mill hardware, belts, mill lumber, drills, air compressors and conveyors. G. Ball, Webb City, superintendent.

New Jersey

JERSEY CITY.—The Air-Reduction Co., 177 Pacific Ave., has awarded the contract for the construction of a 4-story, 40 x 110 ft. reinforced concrete addition to its plant, to James Mitchell, 76 Montgomery St. Estimated cost, \$40,000.

NEWARK.—The Essex Foundry Co., Murray St., will build a 1-story, 75 x 180 ft. brick and steel factory on Elm St. Estimated cost, \$25,000.

New York

BROOKLYN.—The Kollmorgen Optical Co., 35 Steuben St., has awarded the contract for the construction of a 19 x 38 ft. concrete addition to its factory at Steuben St. north of Park Ave., to Metropolitan Cornice & Sheet Metal Works, Flushing and Metropolitan Aves. Estimated cost, \$5,000.

BROOKLYN.—The Improved Appliances Co., 455 Kent Ave., has awarded the contract for the construction of a 4-story, 60 x 92 ft. reinforced concrete and brick addition to its factory to Rufus H. Brown, 350 Fulton St. Estimated cost, \$15,000. Noted June 15.

NIAGARA FALLS.—The United States Light & Heat Corporation has awarded the contract for the construction of a 1-story, 150 x 300 ft. factory for the manufacture of lighting equipment and storage batteries, to Lauer & Mack, 1834 Pierce Ave. Estimated cost, \$75,000.

PEARL RIVER.—The Lederle Antitoxin Laboratory has awarded the contract for the construction of 2-story, 36 x 54 ft. brick veterinary laboratory to Ferber Construction Co., 16 Johnson Ave., Hackensack, N. J. Estimated cost, \$25,000.

SYRACUSE.—The Brown-Lipe-Chapins Co., 110 Seneca St., will build a 2-story, 60 x 120 ft. concrete and brick factory for the manufacture of gears. Estimated cost, \$35,000. Taylor & Bouta, Gurvey Building, architects.

SYRACUSE (Split Rock).—The Sement-Solvay Co., River Road and Tonawanda St., Rochester, will rebuild its plant consisting of three T. N. T. plants, one nitric acid plant, one office building, one laboratory and one boiler house, at Milton Ave., Split Rock, which was recently destroyed by fire.

Ohio

AKRON.—City plans to build a modified Imhoff sewage disposal plant for Summit County Infirmary buildings. Estimated cost, \$18,000. M. P. Lauer, 707 Peoples Saving and Trust Building, engineer.

CINCINNATI.—The Lodge & Shipley Machine Co., 3055 Colerain Ave., will build a 1-story, 90 x 540 ft. concrete, brick and steel building for the manufacture of lathes. Estimated cost, \$100,000. Zettel & Rapp, Johnston Building, architects.

CINCINNATI.—John H. McGowan Co., 52 Central Ave., will build a 2-story, 87 x 90 ft. concrete and brick factory for the manufacture of pumping and hydraulic machinery. Tietig & Lee, Fourth National Bank, architects.

CLEVELAND.—The International Steel Tie Co., 16702 Waterloo Rd., will build a 1-story, 50 x 220 ft. steel factory. Estimated cost, \$30,000.

CLEVELAND.—The New York Central Railway, St. Clair and West 3d Sts., will build a 1-story, 97 x 263 ft. reinforced concrete, brick and steel locomotive repair shop at 564 East 152d St. Estimated cost, \$150,000.

CLEVELAND.—K. V. Painter, 3240 Fairmount Blvd., has awarded the contract for the construction of a 2-story, 108 x 132 ft. reinforced concrete and mill construction factory and salesroom for the manufacture of automobiles, to A. K. Kilbourne Co., 505 Wetland Building. Estimated cost, \$50,000.

CLEVELAND.—The Steel Products Co., 2196 Clarkwood Ave., has awarded the contract for the construction of a 1-story, 92 x 100 ft. concrete and brick addition to its factory at East 65th St., to S. W. Emerson, 1900 Euclid Building. Estimated cost, \$14,000.

CLEVELAND.—The Western Machine Products Co., 7209 St. Clair St., has awarded the contract for the construction of a 2-story, 105 x 122 x 126 ft. concrete, brick and steel addition to its machine shop to Christian-Schwarzenberg & Guede Co., 1900 Euclid Building. Estimated cost, \$25,000.

EUCLID.—The Bishop-Babcock-Becker Co., 1303 East 40th St., will build a group of factory buildings on a 26-acre site on Bliss Road for the manufacture of tacks, nails and brass.

MARIETTA.—The United States Government will build machine shops here for repairing Ohio River dams in Wheeling District. Address Col. H. W. Stickle, Wheeling West Virginia.

SPRINGFIELD.—The Eagle Engineering Co., West Main St. and Bell Ave., will build a 1-story, 50 x 160 ft. reinforced concrete, brick and steel factory. Estimated cost, \$15,000.

STRUTHERS.—The Struther Furnace Co. has awarded the contract for the construction of a river intake plant to Baker, Dunbar & Allen, Union Arcade, Pittsburgh, Pa. Estimated cost, \$102,000.

Oklahoma

BARTLESVILLE.—The United States Government, Bureau of Mines, will build a 1-story, 40 x 100 ft. laboratory here.

COMMERCE.—The Safeguard Mining Co. will build a 200-ton concentration plant requiring lumber, mill hardware, boilers, engine, crushers, sludge and slime tables. Estimated cost, \$70,000.

DOUTHAT.—The Maurice Mining Co. will build a 200-ton concentration plant. Estimated cost, \$75,000. The company is in the market for a derrick, sludge and slime tables, lumber, mill hardware, crushers, boilers, engine, conveyors and compressors.

GRANBY.—The Granby Consolidated Mines Co., Miami, will build a 200-ton concentration plant and install sludge tables, motors, mill lumber, mill hardware, air compressors, ore track, bins, slime tables, boilers and engines. Estimated cost, \$13,000. W. G. Wilkerson, superintendent.

LINCOLNVILLE.—The Miami Sunrise Mining Co., Miami, will build a 200-ton concentration plant at its mine near here requiring sludge tables, jigs, engine, belts, drills, lumber, mill hardware and air compressors. Estimated cost, \$60,000.

LINCOLNVILLE.—The Nemo Mining Co. will remodel its 200-ton concentration plant and install machinery, including sludge tables, belts, crushers and drills. Estimated cost, \$10,000.

MIAMI.—The Picher-Oklahoma Mining Co. will build an 800-ton concentration plant requiring sludge and slime tables, mill hardware, crushers, air compressors, belts and ore cars. Estimated cost, \$75,000. A. J. Harrington, superintendent.

MIAMI.—The United Development Co., Oklahoma City, will build a 250-ton concentration plant and install machinery, including mill hardware, lumber, roofing, engine, boilers, crushers, belts and air compressors. Estimated cost, \$75,000. V. E. Conkle, superintendent.

OKLAHOMA CITY.—The Indian Chief Mining Co. will build a 200-ton concentration plant. B. C. Clark, Purcell, president.

PEORIA.—The Dallas Miami Mining Co. will build a 250-ton concentration plant. Estimated cost, \$65,000. The company is in the market for sludge and slime tables, motors, belts, track, ore cars, mill hardware, crushers, boilers, engine and compressors. A. J. Herrington, superintendent.

PEORIA.—The King Bee Mining Co. will build a 200-ton concentration plant and install machinery, including sludge and slime tables, drills, compressors, belts, mill hardware, ore cars and lumber. Estimated cost, \$60,000.

PEORIA.—The L. C. H. Corporation has awarded the contract for the construction of a 200-ton concentration plant to Hess Construction Co., 1831 Moffet Ave., Joplin, Mo. Estimated cost, \$45,000. The company is in the market for sludge and slime tables, mill hardware, lumber, crushers, engine, boilers, belts and air compressors.

PICHER.—The Ottawa Metal Co. will build a 175-ton concentration plant requiring mill supplies, lumber, hardware, engine, jigs, boilers, crushers, air compressors, belts, ore cars and conveyors. Estimated cost, \$45,000.

PICHER.—The Picher Lead Co. will build a 200-ton concentration plant. Estimated cost, \$60,000. The company will install sludge and slime tables, mill lumber and hardware, ore cars, track, belts, engine, boilers, drills, air compressors and pipes. G. Potter, superintendent.

QUAPAW.—The Quapaw Jack Lead & Zinc Co. will build a 200-ton concentration plant and install machinery, including drills, air compressors, sludge and slime tables, mill hardware, scales, belts, crushers and conveyors. Estimated cost, \$65,000. B. W. Ward, superintendent.

QUAPAW.—The Quapaw Mining Co. will build a 250-ton concentration plant requiring mill hardware, sludge and slime tables, drills, belts, rope and air compressors. Estimated cost, \$72,000.

QUAPAW.—The Ruth Strike Mining Co. will build a 300-ton concentration plant and install machinery, including crusher, jigs, compressor, gas engine, sludge and slime tables, lumber, mill hardware, belts, track and ore car. Estimated cost, \$80,000. A. O. Baker, Shawnee, superintendent.

SPAVINAW.—The Red Granite Copper and Water Power Co., Strand, will build a concentration plant. Estimated cost, \$25,000. The company is in the market for crushers, engine, boilers, ore cars, bins, lumber, track, screens, belts and mill hardware. W. E. Hudson, Connor Hotel, Joplin, Mo., superintendent.

ST. LOUIS.—The Miami Wonder Mining Co., Miami, will build a 200-ton concentration plant at its mine near St. Louis and install crushers, mill machinery, sludge and slime tables, belts, engine, rollers, drills, boilers, air compressors. Estimated cost, \$60,000. A. V. Ellis, superintendent.

Pennsylvania

PHILADELPHIA.—The Niles-Bement-Pond Co., 21st and Callowhill Sts., has awarded the contract for the construction of a 1-story, 65 x 115 ft. addition to its foundry on Ruffner and Donath Sts., to Austin Co., Bulletin Bldg. Estimated cost, \$20,000.

RUTHERFORD.—The Philadelphia & Reading Railway has awarded the contract for the construction of a 1-story, 100 x 150 ft. brick and steel machine shop to E. Warfel, Lancaster. Estimated cost, \$40,000.

Rhode Island

PAWTUCKET.—The Potter & Johnston Co., Newport Ave., has awarded the contract for the construction of a 1-story, 171 x 486 ft. mill construction plant for the manufacture of shells to O. D. Purington & Co., Industrial Trust Bldg., Providence. Estimated cost, \$150,000.

Texas

BROWNWOOD.—The Brownwood Glass Manufacturing Co. will build a glass factory. Estimated cost, \$100,000. H. Wagner, Tulsa, Okla., president.

CISCO.—The Liberty Refining Co., C. A. Gray Building, will build an oil refinery here. G. J. Ames, president.

Washington

SEATTLE.—The Alaskan-Copper Works, 1041 Railroad Ave., will build a 1-story, 50 x 87 ft. machine shop at 3600 East Marginal Way. Estimated cost, \$6,000. Frank Cruise, Washington Block, architect.

SEATTLE.—The Seattle Pipe & Galvanizing Co., 1st Ave. South and Stacy St., has awarded the contract for the construction of a 1-story, 52 x 150 ft. plant for galvanizing ship supplies and heavy hardware to Geo. Eckman, Pacific Block. Estimated cost, \$40,000.

SEATTLE.—P. J. Appleton, 1111 1st Ave., has awarded the contract for the construction of a 2-story, 43 x 114 ft. foundry and machine shop at 1410 Dearborn St. to W. Huskamp, 1355 John St. Estimated cost, \$5,000.

Quebec

TEMISKAMING.—The Kipawa Fibre Co., in which the Riordan Pulp & Paper Co., 355 Beaver Hall Sq., Montreal, is interested, will build a pulp and paper plant.

Wisconsin

MILWAUKEE.—The Standard Steel Corporation, Hopkins Rd. and Lake St., will build a 2-story, 60 x 200 ft. factory and a 40 x 140 ft. foundry. F. D. Chase, 122 S. Michigan Ave., Chicago, Ill., architect. E. J. De Guenther, 908 Majestic Building, interested.

Industrial Notes

THE SCIENTIFIC UTILITIES Co., INC., 84 East 10th Street, New York City has recently been established by C. Grunberg, formerly with the American Scientific Instrument Co. The new company is a modern glass blowing shop and is prepared to furnish the trade with special apparatus.

THE TRAYLOR ENGINEERING AND MANUFACTURING Co. of Allentown, Pa., announce the following election of officers: Mr. Samuel W. Traylor, chairman of the board, Mr. William J. Roberts, president and Mr. H. Battersby, vice-president and treasurer.

THE MULTI METAL Co., INC., is the new name for the Multi Metal Separating Screen Co., which took effect July 1, 1918.

THE ASBOMET COMPANY OF PITTSBURGH, (formerly the Asbestos Protected Metal Company) announces the removal of its

Chicago office on July 1, 1918, to the Railway Exchange Building. Mr. J. T. O'Neill will continue in charge as district manager.

THE INDUSTRIAL ELECTRIC FURNACE COMPANY, Chicago, makers of the Snyder Electric Furnace, are installing a three-ton furnace in the new building of the Atlantic Foundry Company, Akron, Ohio. It is a three-phase furnace built for acid operation on general steel casting work, and was purchased after investigation by Chas. Reymann, president and general manager, and John Steckel, treasurer and purchasing agent, of the Atlantic Foundry Co.

THE PYROELECTRIC INSTRUMENT CO., 626 East State Street, Trenton, N. J., announce that the Northrup-Ajax high-frequency induction furnace developed by Dr. E. F. Northrup for the Ajax Metal Company of Philadelphia is now available for scientific and experimental purposes in five sizes—6 kw., 8 kw., 12 kw., 16 kw. and 20 kw. This furnace operates upon a radically new principle and is said to give results not obtainable by any other type of electric furnace heretofore invented. It is fully described in a new twenty page illustrated circular just issued by the Pyroelectric Company. To those interested in acquiring one of these furnaces this circular will be sent upon request.

PITTSBURGH TESTING LABORATORY announces the removal, July 1st, 1918, from its temporary quarters in the B. F. Jones Law Building to its new office and laboratory buildings at 612-620 Grant Street, Pittsburgh, Pa. Our laboratories will be larger and better equipped than they were in our old quarters, the F. T. L. Building, at Seventh and Bedford Avenues, which we turned over to the Government on April 1st, 1918.

THE H. KOPFERS COMPANY, Pittsburgh, Pa., has been awarded a contract by the Jones and Laughlin Steel Company for the construction of a by-product coke plant of 300 ovens, which will have a carbonizing capacity of approximately 2,000,000 tons per year, which will replace beehive coking capacity of that amount. This plant will be equipped for the recovery of ammonia in the form of ammonium sulphate, of tar, and of benzol and toluol as pure products. The ammonium sulphate and pure toluol will be sold to the Government for war purposes. The steel company plans to use the gas in its steel plant operations.

A NEW 6-TON ACID OPEN-HEARTH FURNACE has recently been completed by the Atlantic Steel Castings Co., Chester, Pa., for the production of special light castings of nickel steel. The company is engaged on Government war work.

THE ZENITH FURNACE Co., Duluth, Minn., have retained Freyn, Brassert & Co., People's Gas Building, Chicago, for the remodeling of their furnace, the installation of a Brassert gas-washing and drying unit, the erection of a new hot-blast stove and other plant improvements.

FOUR NEW GAS PRODUCERS, built by the Morgan Construction Co., Worcester, Mass., are being installed at the Youngstown Sheet & Tube Company's plant at Youngstown, Ohio, to replace four old producers.

THE HANGING ROCK IRON Co., Hanging Rock, Ohio, have awarded a contract to the A. G. McKee Co., Cleveland, for improvements to the Hamilton plant which will include a skip bridge, revolving distributor, two scale cars and a one 50-ton transfer car.

THE CANADIAN FERRO ALLOYS, LTD., Shawinigan Falls, Que., Canada, is building a plant for the production of ferroalloys. They expect to ship in addition to their regular products, 17 tons of 50 per cent ferrosilicon daily.

Manufacturers' Catalogs

THE CUTLER-HAMMER MANUFACTURING Co., Milwaukee, Wisconsin: A pamphlet on battery charging equipment for electric vehicles and industrial trucks. Another pamphlet is issued by the above company on C-H 9116 starting switch for squirrel cage motors.

THE CLARAGE FAN COMPANY, Kalamazoo, Mich.: Catalog No. 22 on style "C" pressure blowers giving a general description, general data and capacity tables.

THE P. H. & F. M. ROOTS COMPANY, Connersville, Ind.: Catalog 63 on the Roots Rotary Gas Exhausters. The predominant feature is the publication of tables of engineering data, designed to make the catalog valuable as a reference book to any one interested in the manufacture or use of gas. This catalog describes and illustrates rotary gas exhausters for foul gas pumping service, corrosive gas handling with high-pressure booster service and special linings.